ESTERLINE ANGUS

E 1124E

INSTRUMENTS

INSTRUMENTS

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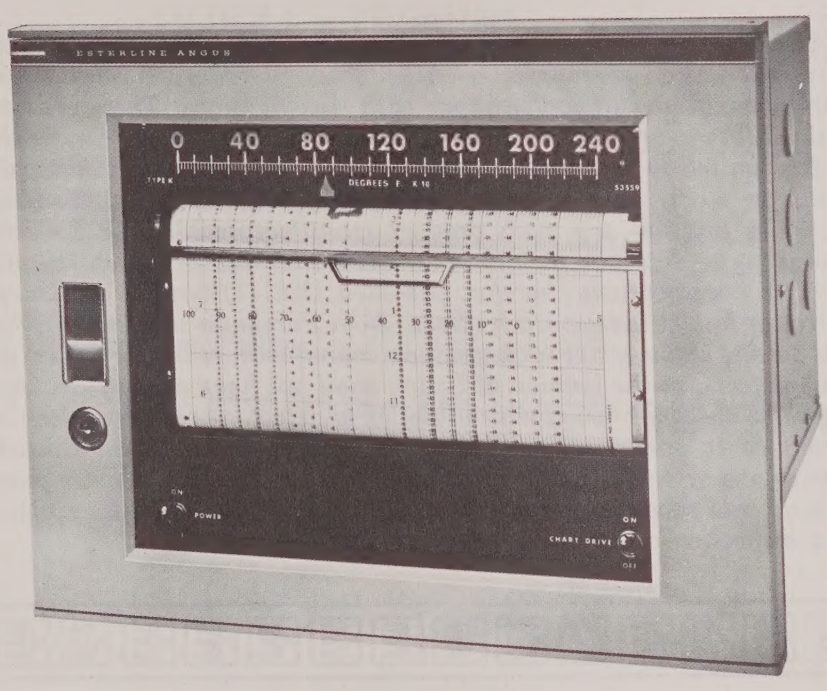
INSTRUCTION MANUAL



MODEL E1124E
MULTIPOINT RECORDER

NOTE: FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED IN A SEPARATE ENVELOPE AT THE BACK OF THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED FOR YOUR RECORDER WILL BE LISTED ON THE DATA SHEET AND WILL BE FOUND IN THE APPENDIX OF THIS MANUAL.

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INSTRUCTIONS FOR OPTIONAL FEATURES

(SEE DATA SHEET FOR SUPPLEMENTS SUPPLIED)

SUPPLEMENT NO.

ADJUSTABLE ZERO/ADJUSTABLE SPAN (AZAS)..... AZAS-1
ANALOG PEN..... 51499-S
AUTOMATIC DUAL-RANGE WITH PROGRAMMED PRINTING..... 51002DR/PP
DUAL-RANGE RECORDING..... 51002DR
EVENT PEN..... 61250-S
FORTY-EIGHT POINT RECORDER..... M51040
MULTIRANGE (MILLIVOLT)..... 5008-S
NON-SELECTIVE ALARMS..... 54189-S
PRINT-ON-ALARM..... 50831-S
PROGRAMMED PRINTING 51002PP-5
PULSE-INPUT-PROPORTIONAL CHART DRIVE..... 70200-S
RETRANSMITTING POT..... 54051-S
SELECTIVE ALARMS..... 51023S-1
THERMOCOUPLE BURNOUT..... 54052-S
THREE-WIRE WHEATSTONE BRIDGE..... 5003-S1

DATA SHEET (Customized Specifications).....(Envelope)

NOTE: Refer to Production Change Notices (PCN's) found in the Appendix. These PCN's contain latest design features and manual corrections which supersede original information in the manual.

PART 1
GENERAL INSTRUCTIONS

SECTION I - DESCRIPTION

ESTERLINE ANGUS SERIES "E" RECORDERS ARE DESIGNED FOR PERMANENT FLUSH INSTALLATIONS IN RELAY RACKS, SWITCHBOARDS, OR PANELS. THE INSTRUMENT IS ALSO SUPPLIED WITH BRACKETS FOR WALL MOUNTING AND MAY BE ADAPTED FOR BENCH-TOP USE WITH THE ADDITION OF OPTIONAL LABORATORY FEET. THE STURDY, RUST-PROOF CASE IS VERY COMPACT FOR A WIDE-CHART INSTRUMENT; AND, AS POINTED OUT IN FIGURE 1.1, THE DOOR HAS A LARGE VIEWING WINDOW AS WELL AS A RECESSED LATCH AND LOCK FOR A COMPLETELY FLUSH APPEARANCE.

SOME OF THE STANDARD OPTIONAL CASE FEATURES OFFERED IN THE SERIES "E" LINE INCLUDE INTERNAL FLUORESCENT OR INCANDESCENT LIGHTING (MOUNTED ON MAIN FRAME MECHANISM), SIDE CARRYING HANDLES, AND RUBBER LABORATORY FEET.

THE CHART FRAME AND MAIN FRAME MECHANISMS SWING OUT OF THE WAY TO AFFORD THE OPERATOR QUICK ACCESS TO INTERNAL RECORDER COMPONENTS AND ADJUSTMENTS. THIS FEATURE GREATLY SIMPLIFIES ROUTINE MAINTENANCE AND SERVICING.

THE INSTRUMENT IS SHIPPED FROM THE FACTORY CALIBRATED AND IN GOOD OPERATING CONDITION. TO PRESERVE THESE CHARACTERISTICS, CARE SHOULD BE EXERCISED IN UNPACKING AND INSTALLING THE INSTRUMENT.

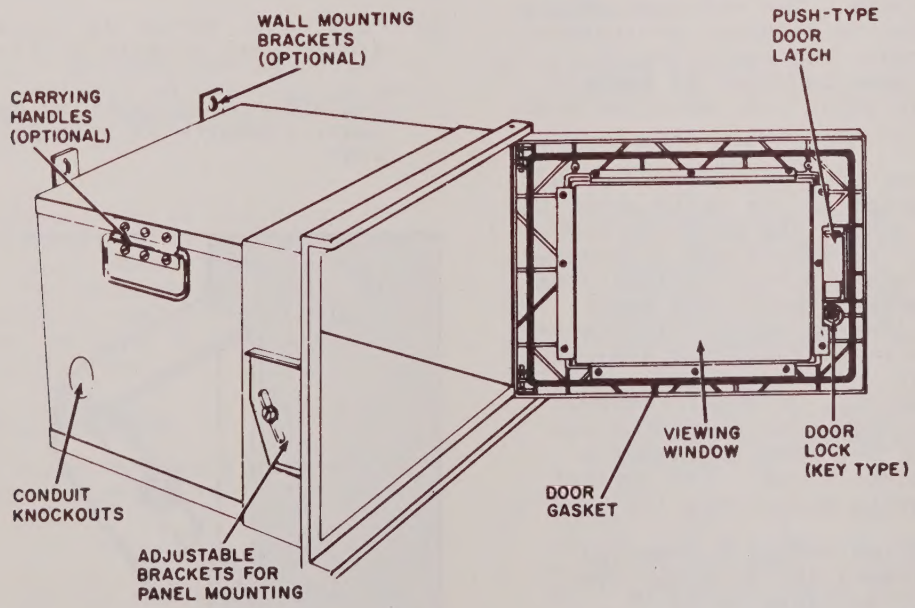


FIGURE 1.1. MAJOR FEATURES OF THE SERIES "E" INSTRUMENT CASE.

SECTION II-INSTALLATION

UNPACKING

A PACKING SLIP LISTING ALL ENCLOSED ITEMS IS INCLUDED WITH EACH SHIPMENT. CHECK OFF THE ITEMS AS THEY ARE UNPACKED; IF ANYTHING IS MISSING, GO THROUGH THE PACKING MATERIAL CAREFULLY BEFORE THROWING IT AWAY. AFTER REMOVING THE INSTRUMENT FROM ITS PACKING CASE, INSPECT THE ASSEMBLY FOR PHYSICAL DAMAGE. IF THE SHIPMENT HAS BEEN DAMAGED IN TRANSIT, NOTIFY BOTH THE CARRIER AND ESTERLINE ANGUS AT ONCE.

CAUTION: DO NOT ATTEMPT TO OPERATE A DAMAGED INSTRUMENT. SEE INSTALLATION PROCEDURES BEFORE REMOVING SHIPPING FASTENERS FROM UNIT.

INSTALLING CASE

THE INSTRUMENT SHOULD BE MOUNTED UPRIGHT AND IN A CLEAN WELL-LIGHTED LOCATION. THE AREA SHOULD BE FREE OF EXCESSIVE DUST, STEAM, MOISTURE, SMOKE OR CORROSIVE FUMES. THE RECORDER SHOULD NOT BE SUBJECTED TO EXTREMES OF TEMPERATURE OR HUMIDITY. IN ADDITION, IT SHOULD NOT BE MOUNTED CLOSE TO LARGE TRANSFORMERS OR CONDUCTORS CARRYING HIGH CURRENTS.

THE DEPTH OF THE CASE IS 14-7/16" FROM THE INSIDE SURFACE OF ITS FRONT MOUNTING FLANGE; SPACE BEHIND THE MOUNTING PANEL, THEREFORE, MUST BE SUFFICIENT TO ACCOMMODATE THIS DIMENSION -- PLUS ADDITIONAL WIRING SPACE WHEN NEEDED. FOR PANEL INSTALLATIONS (EXCEPT RACKS WITH REMOVABLE PANELS) CLEARANCE MUST BE AVAILABLE ON THE SIDES OF THE CASE TO FACILITATE MOUNTING PROCEDURES. WITHOUT FORCED-AIR COOLING, SPACE SHOULD ALSO BE PROVIDED ON ALL SIDES OF THE CASE TO MAINTAIN ADEQUATE AIR CIRCULATION. THE AMBIENT TEMPERATURE SHOULD NOT EXCEED 120°F.

THE PANEL MOUNTING BRACKETS SUPPLIED WITH THE INSTRUMENT ARE SUITABLE FOR USE ON PANEL THICKNESSES UP TO 1" (SEE FIGURE 1.2). IF THE PANELING MATERIAL IS THIN AND OF A LARGE AREA, ADDITIONAL CASE SUPPORTS MAY BE NECESSARY (CONSULT FACTORY).

PANEL CUTOUT REQUIREMENTS ARE APPROXIMATELY 11-7/8" IN HEIGHT AND 16-1/8" IN WIDTH. ADDITIONAL MOUNTING HOLES OR SLOTS ARE NOT REQUIRED. SEE THE MOUNTING DIMENSIONAL DIAGRAM IN FIGURE 1.5.

PANEL MOUNTING PROCEDURES

1) REMOVE HEX-HEAD MOUNTING BOLT FROM EACH SIDE OF CASE. DO NOT REMOVE TIE-DOWNS OR SHIPPING TAGS THAT MAY PROTECT COMPONENTS DURING INSTALLATION.

2) EXAMINE CASE TO SEE THAT ALL COMPONENTS ARE IN OPERATING CONDITION:

   (A) CHECK DOOR HINGE ACTION, DOOR LATCH AND LOCK.

   (B) IF CONDUIT CONNECTIONS ARE REQUIRED, REMOVE KNOCKOUTS FROM CASE. SHOULD CONNECTION MODIFICATIONS BE NECESSARY, PERFORM THIS OPERATION BEFORE, INSTALLING THE CASE.

3) FORM PANEL CUTOUT AS ILLUSTRATED IN DIMENSIONAL DIAGRAM OF FIGURE 1.5.

   CAUTION: PANEL MUST BE OF ADEQUATE STRENGTH TO SUPPORT INSTRUMENT.

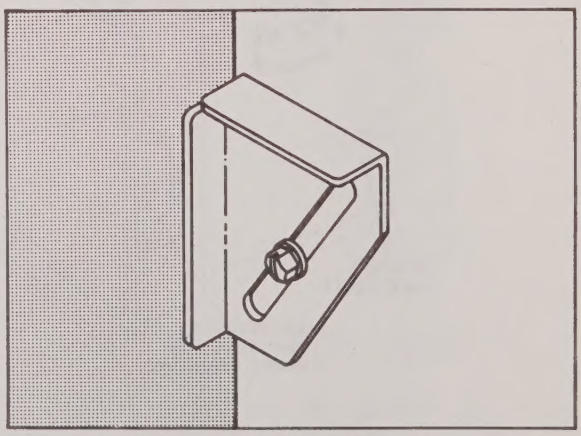


FIGURE 1.2. ADJUSTABLE MOUNTING BRACKETS FOR PANEL INSTALLATIONS.

4) Insert case through front-panel cut-out with case door hinging to the right. Hold case so that inside of flange is flush with front surface of panel.

5) Place one mounting bracket in position against inside of panel on one side of the case. See that slot in bracket lines up with hole in side of case.

6) Insert mounting bolt (previously removed) through the bracket slot and tighten into threaded hole in case.

7) After bolt is finger-tight, force bracket forward so that it presses firmly against inside surface of panel. Tighten the bolt securely with a wrench or screwdriver.

8) Mount the other bracket to the opposide side of the case by following the same procedures given in steps 5, 6, and 7.

9) If panel is of the removable type, it may now be installed in its permanent position with the case attached.

CAUTION: Do not attempt to swing out hinged modules until panel and case are anchored firmly in position.

10) Remove all tie-downs and shipping tags as indicated on the tags or on the instruction sheet affixed to the door glass.

If the instrument will be subjected to vibration or shock, it is recommended that an additional support bracket be installed at the rear of the case. The wall-type brackets supplied with the instrument may be used in the fabrication of a rear support.

WALL MOUNTING PROCEDURES

1) Remove four, flat-head screws which secure the top brackets to the rear of the case.

2) Turn the two top mounting brackets so that the slotted holes are up, and then secure the brackets in position with the four flat-head screws previously removed. See Figure 1.3.

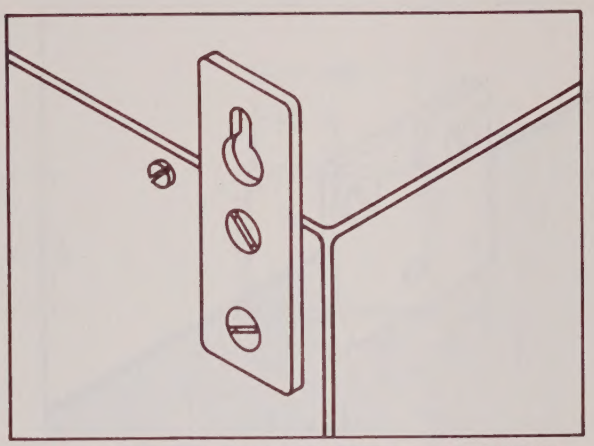


FIGURE 1.3. HANGER-TYPE MOUNTING BRACKETS FOR WALL INSTALLATIONS.

NOTE: Make sure that lower rear bracket in center of case is also secure. See Figure 1.4.

3) Locate and form two top mounting holes in wall to accept 5/16" diameter bolts, and one lower hole to accept a 1/4" diameter bolt.

CAUTION: Wall or bulkhead must have sufficient strength and rigidity to support weight of the instrument.

4) Examine case to see that all components are in operating condition.

(a) Check door hinge action, door latch and lock.

(b) Inspect connection provisions and remove required conduit knockouts from case. Should connection modifications be necessary, perform this operation before mounting the case.

(c) Do not remove tie-downs or shipping tags which are provided to protect components during installation.

5) Install two 5/16" diameter steel bolts into the two top mounting holes in the wall. Large washers or a retaining plate should be used if wall is uneven or if the wall is not solid. Leave bolt heads out far enough to accept mounting brackets.

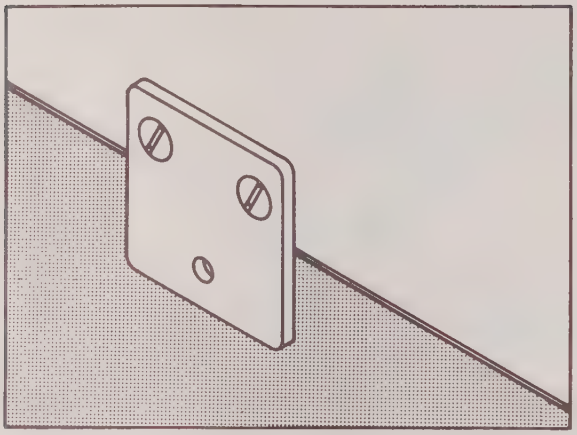


FIGURE 1.4. LOWER MOUNTING BRACKET FOR WALL INSTALLATIONS.

6) Hang case on wall mounting bolts and tighten bolts until instrument is secure.

7) Attach lower mounting bracket to wall using 1/4" diameter steel bolt.

CAUTION: Do not attempt to swing out hinged modules until instrument is anchored firmly to wall.

8) Remove all tie-downs and shipping tags as indicated on the tags or on the instruction sheet affixed to the door glass.

If the instrument will be subjected to vibration or shock, it is recommended that an additional support bracket be installed at the front of the case. The front flange of the case or the panel mounting holes on each side of the case may be useful in fabricating a front support.

BENCH TOP USE

Installation kits are available which facilitate the use of these recorders as portable laboratory instruments. Kit installation instructions are illustrated in Figure 1.6.

CONNECTIONS

Refer to the Terminal Code Plate and to the connection diagrams found in PART 3 of this manual for complete wiring information.

NOTE: When accessories or special attachments form a part of the recorder, their installation and wiring procedures will be found in the APPENDIX in the back of this manual.

After the instrument is properly mounted, but before making connections, open the case door and see that all power switches are off. The instrument case must be connected directly to a good building ground, such as a cold water pipe. DO NOT use conduit as the only ground connection. If the case is mounted on an insulated panel a connection should also be made from the metal case to a convenient building ground.

All wiring should be made through rigid conduit. To relieve strains, however, approximately 16 to 18 inches of flexible conduit should be used to connect directly to the instrument case. Never enclose the signal input and power leads in the same conduit, since measurement errors may result from AC pickup.

CASE DOOR REMOVAL

The Series "E" case is made virtually dust and moisture proof by its door being completely sealed with a rubber gasket. This feature not only protects the precision internal mechanisms from adverse environments, but also stabilizes ambient temperatures within the case. A constant operating temperature becomes very important when measuring and recording low-level signals.

In some applications a sealed case is of no major importance, and the operator may find it more convenient to remove the door so as to take continuous advantage of the tilt-out writing table or to perform periodic adjustments. The complete door assembly may be removed from the case by the following procedure:

1) Open case door. Remove bottom hair pin cotter from the hinge pin in upper left-hand corner of the door Normally, a slight jiggling of the door should cause the hinge pin to drop down, thus releasing the top hinge pin from the case. If hinge

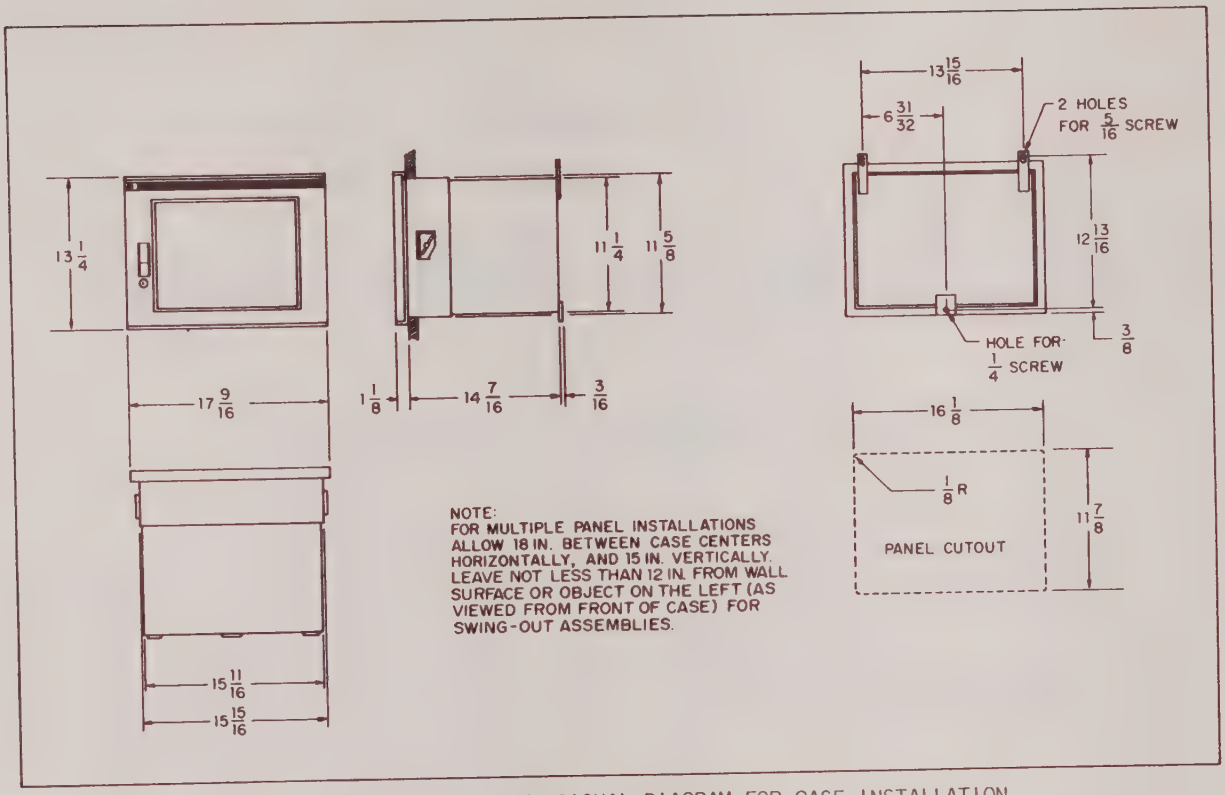


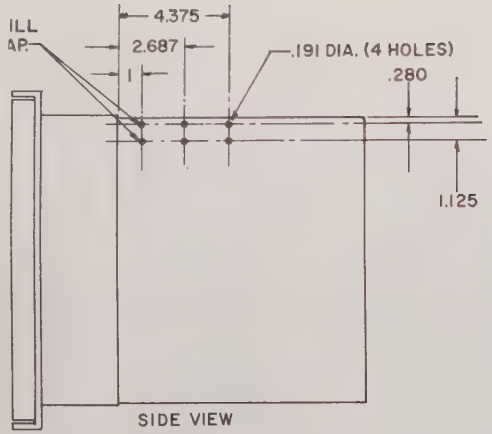
FIGURE 1.5. MOUNTING DIMENSIONAL DIAGRAM FOR CASE INSTALLATION.

PIN DOES NOT DROP DOWN BY ITSELF, MANUALLY PUSH THE PIN DOWNWARD.

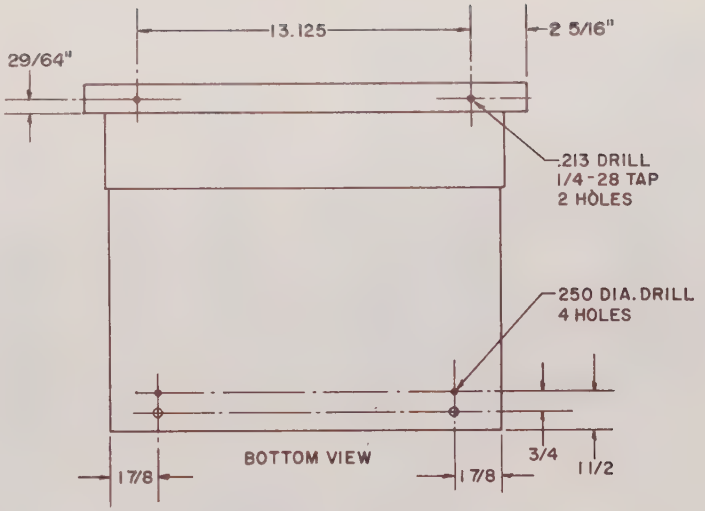
2) AFTER TOP HINGE PIN IS RELEASED FROM THE CASE, TILT DOWN FRONT END OF DOOR UNTIL TOP EDGE OF DOOR CLEARS THE TOP FLANGE OF THE CASE.

3) LIFT UP DOOR TO RELEASE LOWER HINGE PIN FROM BOTTOM FLANGE OF CASE. REMOVE DOOR ASSEMBLY.

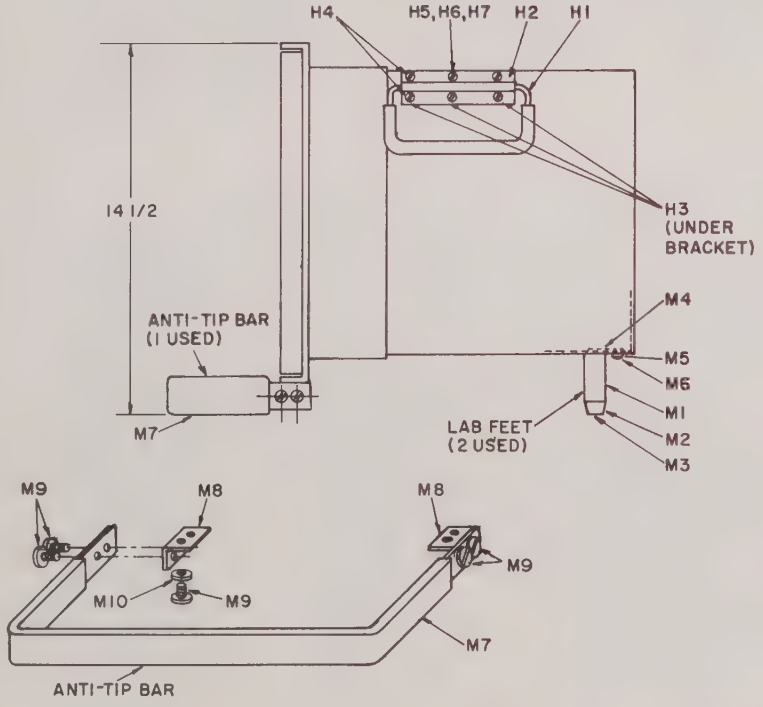
CAUTION: DO NOT LOSE SPACING WASHERS WHEN REMOVING DOOR. NOTE NUMBER AND LOCATION OF WASHERS THAT ARE USED.



LOCATION OF CASE MOUNTING HOLES
FOR CARRYING HANDLES



LOCATION OF CASE MOUNTING HOLES FOR
LAB FEET AND ANTI-TIP BAR



PARTS LIST

LAB HANDLE KIT			
INDEX NO.	DESCRIPTION	PART NUMBER	QTY.
	LAB HANDLE KIT; CONSISTS OF:	51605-3	1
H1	HANDLE, CARRYING	51531-2	2
H2	CLAMP, HANDLE	51531-1	2
H3	WASHER	NX1010	6
H4	SCREW	NX91103	4
H5	SCREW	NX91105	8
H6	LOCKWASHER, SHAKEPROOF	SP1910	12
H7	NUT	X2111	8

LAB FEET AND ANTI-TIP BAR KIT			
INDEX NO.	DESCRIPTION	PART NUMBER	QTY.
	LAB FEET AND ANTI-TIP BAR KIT; CONSISTS OF:	51605-1	1
M1	FOOT	51530	2
M2	BUMPER, FOOT	45024	2
M3	SCREW	1HS1032-36J	2
M4	WELDNUT	51604	2
M5	LOCKWASHER, SHAKEPROOF	SP1910	2
M6	SCREW	NX91103	2
M7	BAR, ANTI-TIP	51528	1
M8	BRACKET	51526	2
M9	SCREW, SOCKET-HEAD	CSH162805	6
M10	LOCKWASHER, SPLIT	ND40221-5	6

FIGURE 1.6. INSTALLATION OF CARRYING HANDLES, LAB FEET, AND ANTI-TIP BAR

PART 2

CHART DRIVE INSTRUCTIONS

SECTION I - DESCRIPTION

This part of the instruction manual covers the Chart Drive portion of the recorder. The chart drive is an accurate and reliable paper-propelling mechanism which has been especially designed for long trouble-free operation. It is an electro-mechanical device that converts electrical energy into linear physical motion through the use of a motor power source and various gear assemblies. The Series "E" chart drives are offered in single as well as multiple speeds to meet all applications of the user. Any given chart drive assembly will include a motor (or motors), a transmission, a chart transport mechanism, and optional accessories when ordered.

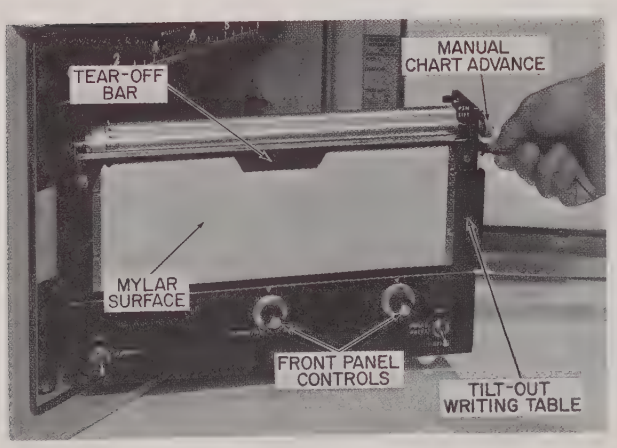


FIGURE 2.1. ENTIRE CHART DRIVE SWINGS OUT OF CASE.

The POWER switch on all recorders turns on the amplifier (or other power supplies when used) and also routes line voltage to the CHART DRIVE switch. This makes it possible to operate the amplifier (or similar internal load) separately for any desired length of time without waste of chart paper and ink.

As shown in Figure 2.1, the Series "E" drives are designed for easy maintenance. The entire assembly is free to swing out of the case for chart loading and all parts are readily accessible for adjustment, cleaning, and lubrication. The chart transport module features a tilt-out writing table and a chart tear-off bar, while the power drive module features front-panel controls and interchangeability.

Series "E" chart drives are currently available in six standard assemblies:

No. 327.....(15 chart speeds)
No. 321.....(10 chart speeds)
No. 303.....(5 chart speeds)
No. 309.....(5 chart speeds)
No. 318.....(2 chart speeds)
No. 300.....(1 chart speed)

The speeds are offered in two English "inch" systems and one Metric "centimeter" system. As an additional option, each drive may be equipped with remote control operable at distances up to several hundred feet. Refer to the Data Sheet in the back of this manual for the type of chart drive supplied with your specific recorder.

TABLE 2.1. TECHNICAL SPECIFICATIONS.

ENERGY SOURCE	SYNCHRONOUS ELECTRIC MOTORS
TIMING BASE	POWER LINE FREQUENCY
TRANSMISSIONS	MECHANICAL GEAR TYPES
SINGLE SPEED (No. 300)	OPTIONAL HR. OR MIN. FEED RATE*
TWO SPEED (No. 318)	OPTIONAL MIN. AND OPTIONAL HR. FEED RATES*
FIVE SPEED (No. 303)	FIVE SELECTABLE HR. FEED RATES
FIVE SPEED (No. 309)	FIVE SELECTABLE MIN. FEED RATES
TEN SPEED (No. 321)	FIVE MIN. AND FIVE HR. SELECTABLE FEED RATES
FIFTEEN SPEED (No. 327)	FIVE HR., FIVE MIN., AND FIVE SEC. SELECTABLE FEED RATES
*MANUAL CHANGE GEARS SUPPLIED.	
STANDARD FEED RATES	OPTIONAL (PER UNIT TIME)
HOURLY RANGE	1/2 TO 960 INCHES PER HR.
MINUTE RANGE	1/4 TO 16 INCHES PER MIN.
SECOND RANGE	1/2 TO 8 INCHES PER SEC.
ALTERNATE FEED RATES	OPTIONAL (PER UNIT TIME)
SPECIAL HOURLY RANGE	3/4 TO 1440 INCHES PER HR.
METRIC HOURLY RANGE	1.25 TO 2400 CM PER HR.
SPECIAL MINUTE RANGE	3/8 TO 24 INCHES PER MIN.
METRIC MINUTE RANGE	0.625 TO 40 CM PER MIN.
SPECIAL SECOND RANGE	3/4 TO 6 INCHES PER SEC.
METRIC SECOND RANGE	1.25 TO 20 CM PER SEC.
CHART TRANSPORT	DIRECT GEAR DRIVE
CHART TAKE-UP	AUTOMATIC REROLL
WRITING TABLE	ADJUSTABLE TILT-OUT TYPE
MANUAL ADJUSTMENTS	CHART ADVANCE AND REROLL KNOBS
OTHER FEATURES	CHART TEAROFF BAR, BUILT-IN TENSION CLUTCHES
PANEL CONTROLS	OPTIONAL WITH MODULES
MAIN POWER (ON-OFF)	ALL MODULES
CHART DRIVE (ON-OFF)	ALL MODULES
HOUR-MINUTE SELECTOR	No. 318 AND No. 321 ONLY
FEED RATE SELECTOR	No. 303, No. 309, No. 321 AND No. 327 ONLY
HOUR-MINUTE-SECOND SELECTOR	No. 327 ONLY
OPTIONAL "LOCAL-REMOTE" SWITCH	ALL INSTRUMENTS
STRIP CHARTS	ROLL TYPE WITH RECTILINEAR COORDINATES
WIDTH	11 INCHES (OVERALL)
LENGTH	120 FEET (CONTINUOUS)
CALIBRATED SPANS	10-INCH (SINGLE CHANNEL) TWO 4-1/2-INCH (TWO CHANNEL)
POWER REQUIREMENTS	20 TO 60 VOLT - AMPERES
SOURCE VOLTAGE	120V AC (± 10%); 240V AC (WITH ACCESSORY TRANSFORMER)
SOURCE FREQUENCY	50 OR 60 Hz
AMBIENT TEMPERATURE RANGE	+ 20° TO + 120° F.
REMOTE CONTROL (OPTIONAL)	OFF-ON; HR., MIN., OR SEC. SELECTION
EXTERNAL SWITCHES	TERMINAL CONNECTIONS PROVIDED
SERVICE FEATURES	SWING-OUT TRANSPORT AND REMOVABLE DRIVE MODULES

DRIVE MODULE 327

THE 327 CHART DRIVE SYSTEM HAS THE REMARKABLE ABILITY TO FURNISH 15 DIFFERENT CHART SPEEDS, WITH VIRTUALLY INSTANTANEOUS CHANGES BEING MADE POSSIBLE BY MEANS OF TWO SIMPLE FRONT-MOUNTED CONTROL KNOBS. AS SHOWN IN TABLE 2.2, THE SLOWEST SPEED IS 0.5 IN./HR.; THE FASTEST, 8 IN./SEC., WHICH RESULTS IN A DIFFERENCE FACTOR OF 57,600 BETWEEN THE SLOWEST AND FASTEST SPEEDS. THIS UNUSUAL RANGE OF 15 DIFFERENT SPEEDS, TOGETHER WITH THE UNIQUE EASE OF SPEED CHANGE, IS ACHIEVED BY THE INCORPORATION OF THE FOLLOWING DESIGN FEATURES:

(A) TWO SYNCHRONOUS ELECTRICAL MOTORS. ONE MOTOR IS REVERSIBLE AND, THROUGH THE USE OF OVERRUNNING CLUTCHES WITHIN ITS GEAR BOX, SERVES AS TWO INDIVIDUAL SOURCES OF DRIVING POWER. THIS MOTOR IS USED FOR ALL "HOUR" AND "MINUTE" CHART SPEEDS. THE OTHER MOTOR RUNS IN ONLY ONE DIRECTION AND IS USED FOR ALL "SECOND" SPEEDS. ITS GEAR BOX ALSO EMPLOYS A CLUTCH BUT FOR REVERSAL PROTECTION.

(B) AN INGENIOUSLY DESIGNED MAIN TRANSMISSION WITH FIVE DIFFERENT RATIOS BETWEEN INPUT AND OUTPUT SPEEDS. GEAR RATIOS ARE SELECTED BY CAM-ACTUATED LEVERS.

(C) OVERRUNNING CLUTCHES, EACH OF WHICH TRANSMITS TORQUE IN ONE DIRECTION BUT NOT IN THE OTHER. THE ACTION OF THESE CLUTCHES WITHIN THE TRANSMISSION IS FULLY AUTOMATIC AND DUPLICATES EXACTLY THE FUNCTION OF SIMILAR LARGER UNITS IN TORQUE CONVERTERS AND OVERDRIVES ON AUTOMOBILES. THE CLUTCHES ARE ACTUALLY INTEGRAL COMPONENTS OF THE TRANSMISSION BUT ARE MENTIONED SEPARATELY BECAUSE OF THEIR UNIQUE APPLICATION.

THE THREE MOTOR CONFIGURATIONS PREVIOUSLY MENTIONED, COMBINED WITH THE FIVE TRANSMISSION RATIOS, YIELD 15 OUTPUT SPEEDS WITHIN THE DIMENSIONAL LIMITS OF A SURPRISINGLY COMPACT ASSEMBLY. BASIC COMPONENTS OF THE DRIVE MODULE ARE PICTURED IN FIGURE 2.2.

ON CHART DRIVE 327, LINE VOLTAGE IS SUPPLIED TO THE HR-MIN-SEC SWITCH WHEN THE CHART DRIVE SWITCH IS TURNED ON. IT WILL BE NOTED THAT THE HR-MIN-SEC SWITCH HAS TWO MIN POSITIONS WHICH ARE COMPLETELY IDENTICAL IN FUNCTION. ONE MOTOR MAY BE TURNED ON AND OFF BY THE HR-MIN-SEC SWITCH; THE OTHER MOTOR MAY HAVE THE ELECTRICAL PHASE SUPPLIED TO ITS QUADRATURE WINDING REVERSED AND THEREBY REVERSING ITS DIRECTION OF ROTATION. THE ON-OFF CAPABILITY OF ONE MOTOR AND THE REVERSIBILITY OF THE OTHER MAKE IT POSSIBLE TO SUPPLY THREE DIFFERENT RPM'S TO THE MAIN TRANSMISSION. ONE MUST ALSO BEAR IN MIND, OF COURSE, THAT THE OVERRUNNING CLUTCHES ARE CONTINUOUSLY FUNCTIONING WHENEVER A CHANGE OF SPEED IS CALLED FOR. BOTH MOTORS ARE PRECISELY SYNCHRONOUS AND ARE EQUIPPED WITH SUITABLE GEAR REDUCTION BOXES SO THAT THE MOTOR OUTPUT RPM'S

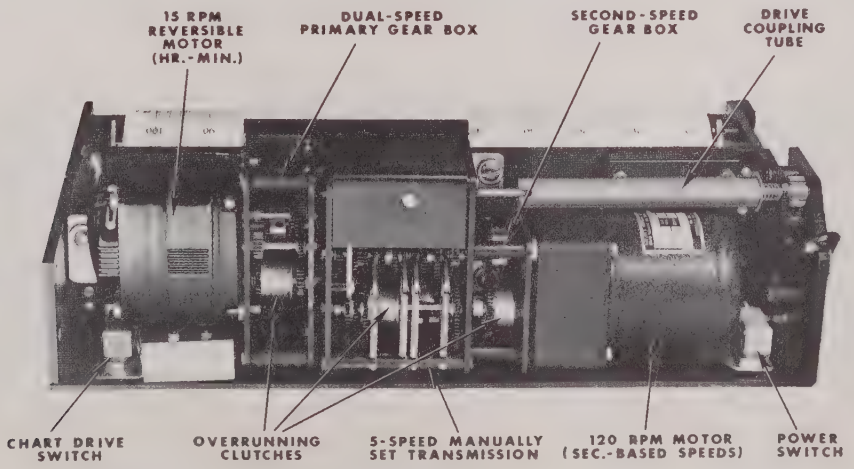


FIGURE 2.2. DRIVE MODULE 327 SHOWING BASIC COMPONENTS.

TABLE 2.2. AUTOMATIC CHART DRIVES.

NO.	TYPE	IN/HR*	IN/MIN*	IN/SEC*
327	15 SPEED AUTOMATIC, DIAL SELECT SPEED	.5, 1, 2, 4, 8	.5,1,2,4,8	.5,1,2,4,8
321-60	10 SPEED AUTOMATIC, DIAL SELECT SPEED	.5, 1, 2, 4, 8	.5,1,2,4,8	
321-30	10 SPEED AUTOMATIC, DIAL SELECT SPEED	1, 2, 4, 8,16	.5,1,2,4,8	
321-15	10 SPEED AUTOMATIC, DIAL SELECT SPEED	2, 4, 8,16,32	.5,1,2,4,8	
321-10	10 SPEED AUTOMATIC, DIAL SELECT SPEED	3, 6,12,24,48	.5,1,2,4,8	
321- 6	10 SPEED AUTOMATIC, DIAL SELECT SPEED	5,10,20,40,80	.5,1,2,4,8	
303-60	5 SPEED AUTOMATIC, DIAL SELECT SPEED	.5, 1, 2, 4, 8		
303-30	5 SPEED AUTOMATIC, DIAL SELECT SPEED	1, 2, 4, 8,16		
303-15	5 SPEED AUTOMATIC, DIAL SELECT SPEED	2, 4, 8,16,32		
303-10	5 SPEED AUTOMATIC, DIAL SELECT SPEED	3, 6,12,24,48		
303- 6	5 SPEED AUTOMATIC, DIAL SELECT SPEED	5,10,20,40,80		
309	5 SPEED AUTOMATIC, DIAL SELECT SPEED		.5,1,2,4,8	

*FOR ALTERNATE INCH SPEEDS, MULTIPLY FIGURES IN ABOVE TABLE BY 1.5. (EXCEPTION: THE MAXIMUM SPEED FOR NO. 327 DRIVE IS 6 INCHES-PER-SECOND).

FOR ALTERNATE METRIC (CM) SPEEDS, MULTIPLY FIGURES IN ABOVE TABLE BY A FACTOR OF 2.5. (EXAMPLE: .5, 1, 2, 4, 8 INCHES BECOME 1.25, 2.5, 5, 10, 20 CENTIMETERS).

†THE CALIBRATION MARKINGS OF .5, 1, 2, 4, AND 8 ON THE "INCHES" SELECTOR DIAL ARE MULTIPLIED BY CORRESPONDING FACTORS OF 2, 4 6, AND 10 TO OBTAIN THESE CHART SPEEDS RESPECTIVELY.

ARE ONLY FRACTIONS OF THE ARMATURE RPM'S (THE LATTER BEING EXACTLY 1800 ON 60-CYCLE CURRENT). THE GEAR REDUCTION BOXES ARE INTEGRAL WITH THE MOTORS AND ARE NOT TO BE CONSIDERED PART OF THE MAIN MULTI-SPEED TRANSMISSION.

THE INCHES CONTROL KNOB IS USED TO MECHANICALLY SELECT ANY ONE OF FIVE DIFFERENT GEAR RATIOS WITHIN THE COMPACT MULTI-SPEED TRANSMISSION. THIS KNOB MAY BE OPERATED AT WILL WITHOUT DAMAGING GEAR TEETH, SINCE PROGRESSIVE DESIGN MAKES THE GEAR MESHING PERMISSIVE AND NOT FORCED. THE DELAY IN MESHING IS NEGLIGIBLE AT ALL CHART SPEEDS.

DRIVE MODULE 321

FIVE STANDARD CONFIGURATIONS OF THE 321 DRIVE ARE CURRENTLY AVAILABLE. EACH CONFIGURATION HAS 10 SPEEDS BUT THE ASSORTMENT OF SPEEDS IS OPTIONAL AS LISTED IN TABLE 2.2.

IT WILL BE NOTED IN TABLE 2.2 THAT EACH DRIVE NUMBER HAS THE SAME ASSORTMENT OF SPEEDS IN IN/MIN. THE DIFFERENCES ARE FOUND IN THE ASSORTMENT OF SPEEDS IN IN/HR. THE INCHES CONTROL HAS FIVE SETTINGS: .5, 1, 2, 4, AND 8. THE HR-MIN SWITCH HAS TWO SETTINGS WHICH ARE SELF-EXPLANATORY.

IN THE 321-60, SWITCHING THE TIME UNIT SELECTOR FROM HR TO MIN (OR VICE VERSA) AUTOMATICALLY CHANGES THE TRANSMISSION GEAR RATIO BY A FACTOR OF 60. SO, FOR ANY CONSTANT SETTING OF THE INCHES SELECTOR, THE CHART SPEED CHANGES BY A FACTOR OF 60 WHEN THE HR-MIN SWITCH IS CHANGED FROM ONE POSITION TO THE OTHER. THE INCHES AND HR-MIN INDICATIONS ARE INTERPRETED DIRECTLY.

IN THE OTHER 321 CHART DRIVES, THIS CHANGE IN GEAR RATIO WHEN THE HR-MIN SWITCH IS OPERATED IS NOT 60. FOR EXAMPLE, IN THE 321-30 THE CHANGE IN GEAR RATIO IS ONLY 30. THEREFORE, FOR A CONSTANT INCHES SETTING, AN HR-BASED SPEED ON THE 321-30 IS JUST TWICE AS

HIGH AS ON THE 321-60, AS SHOWN IN TABLE 2.2. THE OPERATOR IS REMINDED OF THIS BY MEANS OF THE MULTIPLYING FACTOR OF TWO (X2) APPEARING ON THE FRONT PANEL UNDER THE INCHES SELECTOR. IT WILL BE NOTED THAT MIN-BASED SPEEDS NEVER HAVE A MULTIPLIER ON ANY 321 DRIVE; THEREFORE, MIN-BASED SPEEDS ARE ALWAYS READ DIRECTLY FROM THE INCHES SELECTOR DIAL.

FOLLOWING THE SAME ANALYSIS, THE 321-15 CHANGES GEAR RATIOS BY A FACTOR OF 15 WHEN THE HR-MIN SWITCH IS CHANGED FROM ONE POSITION TO THE OTHER. SO, FOR A CONSTANT INCHES SETTING, EVERY HR-BASED CHART SPEED IS EXACTLY FOUR TIMES AS HIGH AS ON THE 321-60. THE OPERATOR IS REMINDED OF THIS BY THE MULTIPLYING FACTOR OF FOUR NEXT TO IN/HR ON THE FRONT PANEL. IN THE 321-15 DRIVE, IF THE INCHES CONTROL IS SET ON .5 AND THE TIME UNIT SELECTOR IS ON IN/HRx4, THE CHART SPEED IS (4 x .5) IN./HR. OR 2 IN./HR., AS SHOWN IN TABLE 2.2. THE 321-10 AND 321-6 DRIVES HAVE MULTIPLYING FACTORS OF 6 AND 10 RESPECTIVELY FOR THEIR HOURLY CHART SPEEDS.

ALL CONFIGURATIONS OF THE 321 CHART DRIVE ARE EQUIPPED WITH ONE MOTOR WHICH IS REVERSIBLE BY ACTUATION OF THE HR-MIN SWITCH. REVERSING THE MOTOR, IN COMBINATION WITH OVERRUNNING CLUTCHES, BRINGS DIFFERENT PRIMARY GEAR TRAINS INTO OPERATION SO THAT THE RPM SUPPLIED TO THE MAIN TRANSMISSION IS APPROPRIATELY CHANGED WHILE MAINTAINING THE SAME DIRECTION OF ROTATION. COMPONENTS OF THIS DRIVE MODULE ARE SHOWN IN FIGURE 2.3.

THE MAIN TRANSMISSION HAS FIVE GEAR RATIOS WHICH ARE SET BY THE INCHES KNOB. THE INCHES KNOB IS PURELY MECHANICAL IN FUNCTION. THE GEARS MAY BE CHANGED AT WILL WITHOUT DAMAGE BECAUSE MESHING IS PERMISSIVE RATHER THAN FORCED.

IT CAN BE SEEN THAT THE TWO-DIRECTIONAL MOTOR, PLUS THE FIVE GEAR RATIOS AVAILABLE IN THE MAIN TRANSMISSION, COMBINE TO FURNISH TEN CHART SPEEDS WHICH MAY BE QUICKLY SELECTED BY THE OPERATOR FROM FRONT-MOUNTED CONTROLS.

DRIVE MODULES 303 AND 309

EACH 303 CHART DRIVE INCORPORATES A NON-REVERSIBLE 15-RPM MOTOR AND SINGLE-SPEED GEAR BOX IN COMBINATION WITH A FIVE-SPEED TRANSMISSION. THE GEAR BOX IS AVAILABLE IN FIVE DIFFERENT FIXED RATIOS, EACH FURNISHING A SPECIFIC RPM TO THE MULTISPEED TRANSMISSION. THE CAM-ACTUATED TRANSMISSION PERMITS THE AUTOMATIC SELECTION OF ANY FIVE IN/HR SPEEDS LISTED IN TABLE 2-2. THESE DRIVE MODULES ARE DESIGNATED 303-60 THROUGH 303-6. THE SINGLE-SPEED GEAR BOXES ARE AVAILABLE AS IN/HR (303-60), IN/HR x 2 (303-30), IN/HR x 4 (303-15), IN/HR x 6 (303-10) AND IN/HR x 10 (303-6). THE MULTIPLYING FACTORS OF 2, 4, 6, AND 10 ARE USED WITH THE FIXED DIAL CALIBRATIONS ON THE INCHES SELECTOR TO DETERMINE THE

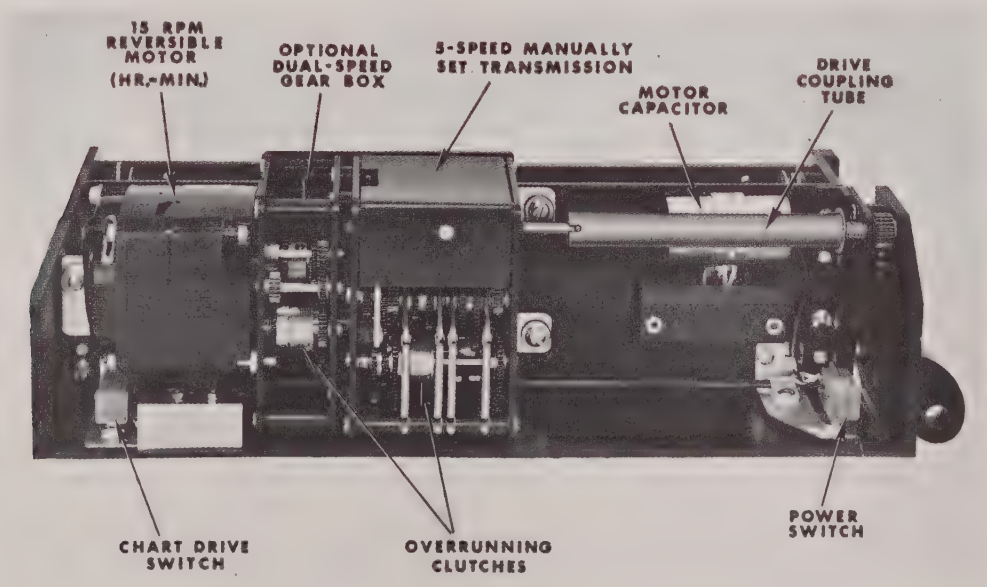


FIGURE 2.3. DRIVE MODULE 321 OFFERS THE OPERATOR 10 CHART SPEEDS.

CHART SPEED IN "INCHES" FOR ANY GIVEN 303 DRIVE.

THE SELECTION OF SPEEDS FOR EACH SPECIFIC DRIVE IS ACCOMPLISHED BY THE POSITIONING OF THE INCHES DIAL ON THE FRONT PANEL OF THE DRIVE MODULE. THE INCHES DIAL MAY BE CHANGED AT WILL SINCE GEAR MESHING IS PERMISSIVE RATHER THAN FORCED.

THE 309 CHART DRIVE INCLUDES THE SAME BASIC COMPONENTS AS THE 303 MODULES EXCEPT ONLY ONE GEAR BOX IS OFFERED FOR STANDARD INCH RANGES. THIS GEAR BOX FURNISHES AN OUTPUT RPM TO THE SELECTABLE TRANSMISSION WHICH IN TURN PRODUCES A FIXED GROUP OF MINUTE SPEEDS RATHER THAN HOUR SPEEDS. IN ALL OTHER RESPECTS, THE 303 AND 309 DRIVE MODULES ARE THE SAME.

DRIVE MODULE 318

THE 318 CHART DRIVE IS COMPOSED OF A REVERSIBLE 15-RPM SYNCHRONOUS MOTOR DRIVING A GEAR BOX EQUIPPED WITH OVERRUNNING CLUTCHES SO AS TO PRODUCE TWO DISTINCT FORWARD RPM'S FOR THE MAIN TRANSMISSION. OUTPUT OF THE TRANSMISSION MAY BE READILY CHANGED BY MEANS OF ACCESSIBLE EXTERNAL CHANGE GEARS. THESE EXTERNAL GEARS CAN BE CHANGED BY REMOVING THE KNURLED NUTS HOLDING THEM TO THEIR SHAFTS, REMOVING THE GEARS, SLIPPING THE OTHER SET OF GEARS ON THE SHAFTS, AND TIGHTENING DOWN THE KNURLED NUTS.

THE HR-MIN SWITCH REVERSES THE MOTOR BY REVERSING THE ELECTRICAL PHASE SUPPLIED TO THE QUADRATURE WINDING. THE 318 DRIVE IS AVAILABLE WITH DIFFERENT GEAR BOXES HAVING STEPDOWN RATIOS OF 60:1, 30:1, 15:1 10:1, OR 6:1. THESE DRIVES ARE DESIGNATED 318-60 THROUGH 318-6. TABLE 2.3 LISTS WHAT CHART SPEEDS MAY BE OBTAINED WITH VARIOUS GEAR-BOX RATIOS AND STANDARD CHANGE GEARS.

DRIVE MODULE 300

THE 300 CHART DRIVE CONSISTS OF A SYNCHRONOUS MOTOR DRIVING A SINGLE-SPEED TRANSMISSION. A SELECTION OF CHART SPEEDS IS MADE POSSIBLE THROUGH THE USE OF EITHER A 1-RPM MOTOR OR A 15-RPM MOTOR IN CONJUNCTION WITH THREE DIFFERENT TRANSMISSIONS--DESIGNATED AS A, B, OR C. THUS, A DRIVE HAVING A 1-RPM MOTOR AND A B TRANSMISSION WILL BE DESIGNATED AS 300-1B. OTHER COMBINATIONS ARE IDENTIFIED IN A SIMILAR MANNER AS SHOWN IN TABLE 2.4.

IN ADDITION TO THE VARIOUS MOTOR-TRANSMISSION COMBINATIONS, THE OUTPUT OF EACH TRANSMISSION IS ALSO MADE VARIABLE BY MEANS OF MANUAL CHANGE GEARS. THESE GEARS ARE READILY ACCESSIBLE AND ARE INTERCHANGEABLE IN THE FIELD. EACH CHANGE GEAR IS HELD IN PLACE BY A KNURLED NUT, THUS MAKING IT POSSIBLE FOR THE OPERATOR TO CONVERT CHART SPEEDS WITHOUT TOOLS. SEE TABLE 2.4 FOR COMPLETE DRIVE DESIGNATIONS AND STANDARD CHART SPEEDS. SPECIAL CHART SPEEDS MAY BE MADE AVAILABLE--CONSULT FACTORY FOR DETAILS.

TABLE 2.3. DRIVE 318 CHART SPEEDS.

MANUAL CHANGE GEARS			DRIVE NUMBER AND SPEEDS IN INCHES									
COLOR CODE	TEETH IN DRIVE GEAR	TEETH IN DRIVEN GEAR	318-60		318-30		318-15		318-10		318-6	
			HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
GOLD	18	72	1	1	2	1	4	1	6	1	10	1
GREEN	30	60	2	2	4	2	8	2	12	2	20	2
RED	45	45	4	4	8	4	16	4	24	4	40	4
GREEN	60	30	8	8	16	8	32	8	48	8	80	8
GOLD	72	18	16	16	32	16	64	16	96	16	160	16

NOTE: FOR ALTERNATE STANDARD INCH SPEEDS, MULTIPLY FIGURES IN ABOVE TABLE BY 1.5. FOR ALTERNATE STANDARD METRIC SPEEDS, MULTIPLY FIGURES IN ABOVE TABLE BY 2.5. (EXAMPLE: 1, 2, 4, 8, 16 INCHES BECOME 2.5, 5, 10, 20, 40 CM).

TRANSPORT MODULE

From the motor drive module to the chart reroll in the transport module, advanced Esterline Angus designing has combined the entire chart drive system on one single swingout assembly. Continuous drive energy is transmitted through this module by simple and straight-forward spur gearing. This eliminates awkward problems of power transfer through worm gears, which often operate under marginally heavy loading because of restrictions on their size, etc. Also, there is no need for a complicated hinge design to accommodate a power shaft. It will be noted that the chart transport assembly can be swung out without disturbing the position of the paper in any way. When the chart drive assembly has been swung out and then reclosed, the pen will resume writing in its correct position.

The universal chart transport mechanism is used with all optional chart drive modules. The transport begins where the transmission or power module ends, and includes all components in the gear train ending with the reroll cylinder. The paper supply roll is also included in this gear train although it is actuated only by tension on the paper itself.

The three rollers in the chart transport system are the paper supply roll, the drive roll, and the reroll cylinder (Fig. 2.4). The supply roll and the reroll cylinder are accessible from the rear of the swingout assembly and can be removed and re-inserted easily by manipulation of retaining clips. The supply roll has a very lightly loaded friction clutch which constantly slips in use so that a slight but firm tension is maintained on the paper being unwound. A slightly heavier clutch in the reroll cylinder also constantly slips in use because gearing is designed so that, under all normal conditions, the reroll cylinder will try to take up paper faster than it can be supplied. A knob is furnished for manual rotation of the reroll cylinder.

The drive roll, located at the top of the chart drive assembly, dominates the motion of the paper. Although a clutch is provided to permit manual rotation by means of a knob, the clutch loading is sufficiently heavy to guarantee that no slippage will occur in normal operation. The paper is "geared" to the drive roll by holes which fit guide pins on the drive roll. No attempt should be made to rotate the drive roll by pulling on the paper, as the holes can almost invariably be expected to tear out.

Any reasonable amount of slack created in the paper by inspection, etc., will be taken up again in a matter of seconds by automatic reroll action. The operator may, of course, take up excessive slack by rotating the reroll cylinder manually. Care should be taken, however, so that only a minimum of forward torque is applied as the paper becomes snug. It is just as well to leave the final

TABLE 2.4. DRIVE 300 CHART SPEEDS.

MANUAL CHANGE GEARS			DRIVE NUMBER AND SPEEDS IN INCHES PER HOUR			
COLOR CODE	TEETH IN DRIVE GEAR	TEETH IN DRIVEN GEAR	300-1A	300-1B	300-15A	300-15C
GOLD	18	72	1	1.5	15	60
GREEN	30	60	2	3	30	120
RED	45	45	4	6	60	240
GREEN	60	30	8	12	120	480
GOLD	72	18	16	24	240	960

NOTE: For Alternate Standard Inch Speeds, Multiply Figures in Above Table by 1.5. For Alternate Standard Metric Speeds, Multiply Figures in Above Table by 2.5. (Example: 1, 2, 4, 8, 16 Inches Become 2.5, 5, 10, 20, 40 cm).

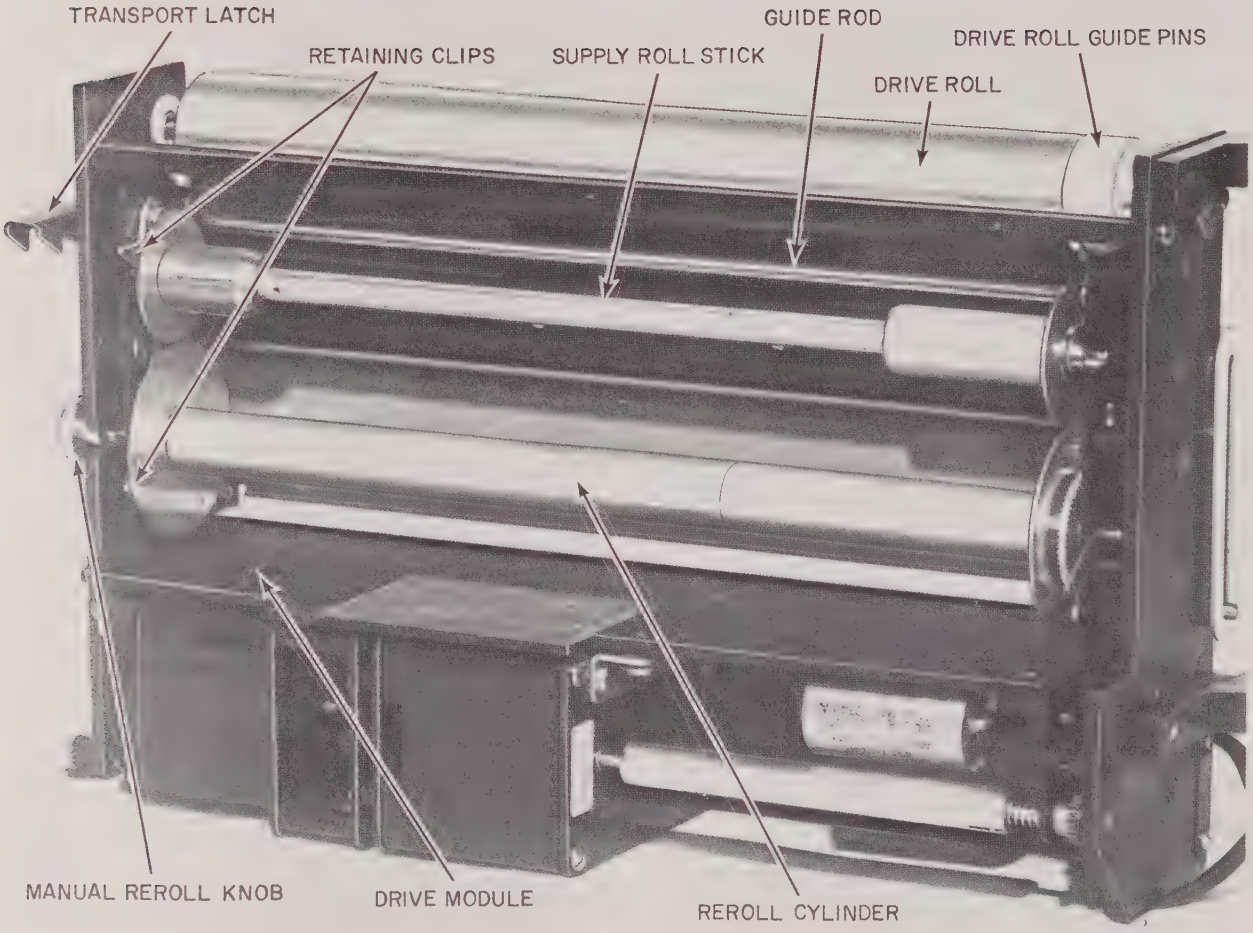


FIGURE 2.4. MAJOR COMPONENTS OF UNIVERSAL TRANSPORT ASSEMBLY.

INCH OR TWO OF TAKE-UP TO THE INSTRUMENT ITSELF.

A CONVENIENTLY LOCATED PIN AT THE RIGHT SIDE OF THE ASSEMBLY ENABLES THE OPERATOR TO SWING OUT THE WRITING TABLE TO ABOUT A 45-DEGREE ANGLE AS SHOWN IN FIGURE 2.5. INGENIOUS GEOMETRY AND ACCURATE MACHINING CAUSE THE TABLE TO LOCK ITSELF INTO NORMAL OPERATING POSITION WITHOUT THE USE OF ANY BREAKABLE CLIPS, NOTCHES, SPRINGS, ETC. SWINGING OUT THE TABLE WILL AUTOMATICALLY DRAW PAPER WITH IT BY A SLIGHT REVERSAL OF THE REROLL ACTION. WHEN THE TABLE IS RETURNED TO ITS NORMAL POSITION, THE SLACK IN THE PAPER WILL BE TAKEN UP AGAIN IN A MATTER OF SECONDS.

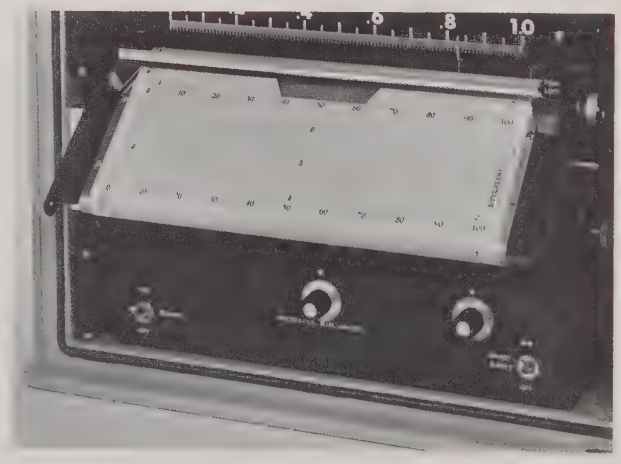


FIGURE 2.5. WRITING TABLE EXTENDED FROM FRONT OF CHART DRIVE.

SECTION II OPERATION

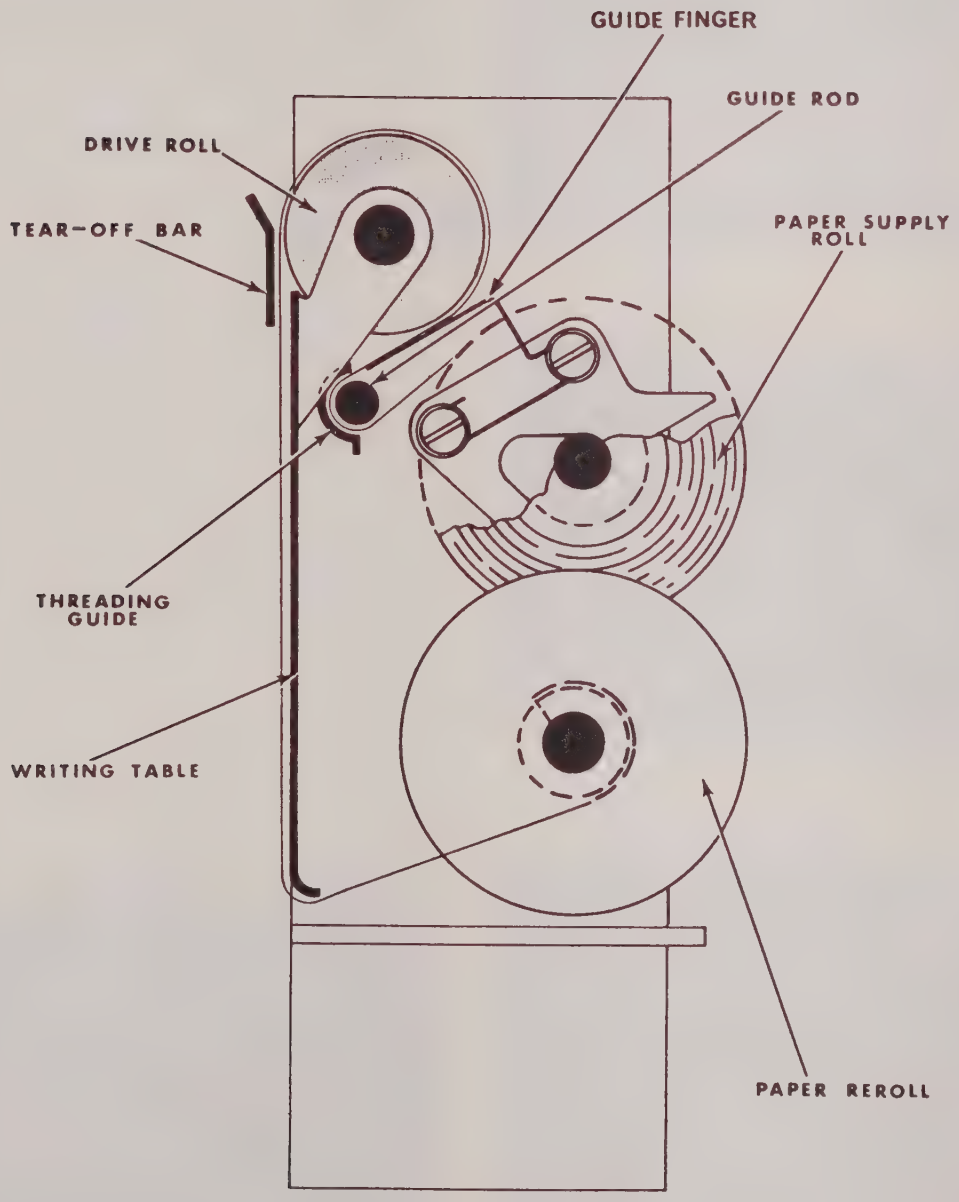


FIGURE 2.6. END VIEW OF TRANSPORT SHOWING ROLLERS AND CHART ROUTING.

OPERATING PROCEDURES

GENERAL

Following are detailed instructions for installing chart paper, operating front-panel controls, and removing rerolled chart from the instrument. Only Esterline Angus precision charts must be used in this recorder to maintain guaranteed accuracy and to insure optimum performance. Before preparing the instrument for operation see that all packing materials have been removed and that the case is properly installed. It is recommended that chart drive power be turned off and that the measuring system be de-energized.

CHARTING

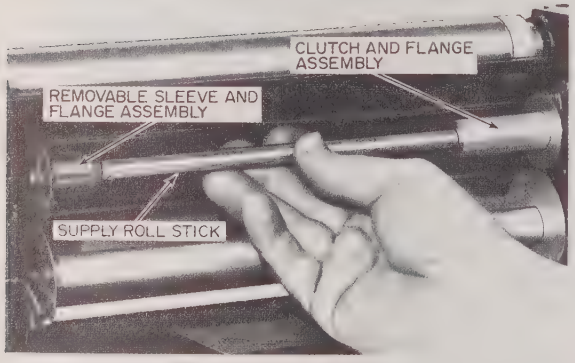
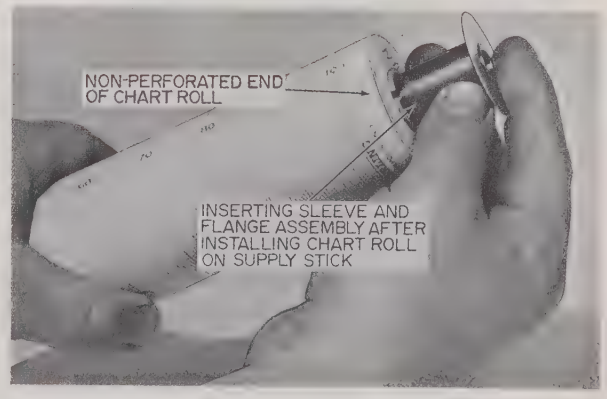


Figure 2.7. Open case door, press down on lever at top-right of chart transport, and swing out entire chart drive assembly. Pull straight outward on supply roll stick and remove stick as shown.

Figure 2.8. Pull sleeve and flange assembly off of supply stick. Strike perforated end of new chart roll against a flat surface to ensure that fibre core of chart roll is flush with edges of paper. Insert open end of supply stick into core at perforated end of chart and let chart roll slide down the supply stick so that the perforated end of chart roll is flush against the flange of the supply stick clutch. Insert sleeve and flange assembly onto the open end of the supply stick and slide sleeve into the core of the chart roll until the spring-loaded detent in the supply stick snaps into the circular groove located on the inner diameter surface of the sleeve.



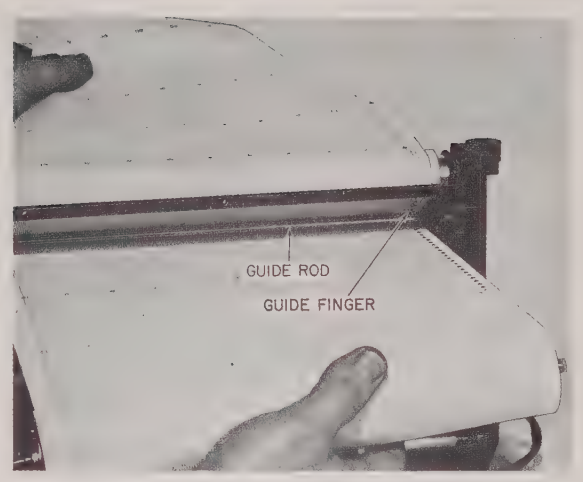


FIGURE 2.9. TEAR OR CUT LEADING EDGE OF PAPER TO A "V" SHAPE, AND SLIGHTLY TURN UP THE POINT. WITH PERFORATED END OF THE SUPPLY ROLL TO THE RIGHT, ROUTE AS FOLLOWS: (1) ROUTE "V" END OF PAPER UNDER AND OVER THE ROUND GUIDE ROD, (2) ROUTE PERFORATED END OF PAPER BETWEEN GUIDE FINGER AND PINS ON DRIVE ROLL, (3) THEN PULL "V" END OF PAPER UP AND OVER DRIVE ROLL. SEE CHART ROUTING DIAGRAM IN FIGURE 2.6.

FIGURE 2.10. ROUTE PAPER DOWNWARD BETWEEN TEAR-OFF BAR AND WRITING TABLE--MAKING SURE THAT PINS ON DRIVE ROLL ENGAGE PERFORATIONS IN PAPER. ADVANCE PAPER USING DRIVE ROLL KNOB AND TEAR OFF A PORTION OF CHART AS PICTURED HERE.

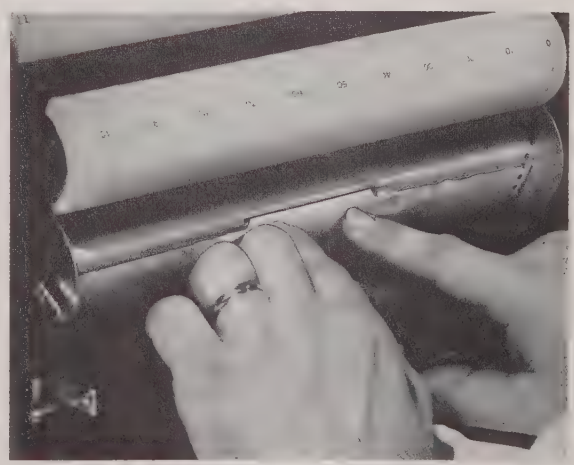


FIGURE 2.11. ROUTE PAPER DOWNWARD AND THROUGH OPENING AT BOTTOM OF WRITING TABLE. ALIGN SLOTS IN BOTH SECTIONS OF REROLL CYLINDER. GUIDING PAPER UNDER REROLL CYLINDER, INSERT TAB ON LEADING EDGE OF PAPER INTO SLOT AS SHOWN. HOLDING RIGHT-HAND FLANGE OF REROLL CYLINDER, ADVANCE REROLL KNOB SO THAT TAB IS CLAMPED IN THE SLOT AND PAPER BEGINS TO WRAP AROUND THE REROLL CYLINDER. RELEASE RIGHT-HAND FLANGE AND ADVANCE REROLL KNOB TO TAKE UP CHART SLACK. SWING CHART DRIVE BACK INTO POSITION SO THAT IT LATCHES TO THE MAIN MECHANISM. THE TRANSPORT IS NOW CHARTED AND READY FOR OPERATION.

CAUTION: USE DRIVE ROLL KNOB TO ADVANCE CHART. DO NOT USE REROLL KNOB.

OPERATING CONTROLS

After making the proper electrical connections, installing the chart, and preparing the writing system for recording, the instrument may be put into operation in the following manner.

DRIVE MODULE 300

1) Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2) Turn on CHART DRIVE switch. This energizes the chart drive motor and causes the chart paper to be driven at a speed determined by the optional style of drive employed.

3) To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULES 303 AND 309

1) Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2) Select chart speed by setting the INCHES PER MINUTE or INCHES PER HOUR dial to desired speed.

NOTE: The front-panel dial will be calibrated in centimeters instead of inches for all metric chart drives.

3) Turn CHART DRIVE switch on. This energizes the chart drive motor and causes the paper to be driven at the speed indicated by the front-panel dial.

4) To change speed, turn the INCHES PER MINUTE or INCHES PER HOUR knob to the desired speed. This may be done at any time, whether the chart is being driven or not.

5) To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULE 318

1) Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2) Place HR-MIN switch in desired position.

3) Turn on CHART DRIVE switch. This applies AC excitation to one winding of the chart drive motor and also to the HR-MIN switch, which routes power to the quadrature winding of the reversible motor in a phase determined by the setting of the switch. The chart will now begin moving at a rate determined by the basic style of drive and the HR-MIN setting.

4) To change chart speed, actuate the HR-MIN switch. This switch may be operated at any time--with power on or off.

5) To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULE 321

1) Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2) Select chart speed by setting INCHES selector and HR-MIN switch to desired positions.

NOTE: The front-panel dial will be calibrated in centimeters instead of inches for all metric chart drives.

Turn on CHART DRIVE switch. This energizes one winding of the reversible motor and also applies power to the HR-MIN switch, which routes

POWER TO THE QUADRATURE WINDING OF THE MOTOR IN A PHASE DETERMINED BY THE SETTING OF THE SWITCH. THE CHART WILL NOW MOVE AT THE SELECTED RATE.

4) TO CHANGE CHART SPEED, ACTUATE THE INCHES SELECTOR AND/OR THE HR-MIN SWITCH. THESE CONTROLS MAY BE CHANGED WITH POWER ON OR OFF.

5) TO STOP THE CHART PAPER, PLACE THE CHART DRIVE SWITCH IN ITS OFF POSITION.

DRIVE MODULE 327

1) TURN ON POWER SWITCH. THIS ROUTES AC POWER TO THE CHART DRIVE SWITCH AND ENERGIZES THE MEASURING SYSTEM IF POWER IS REQUIRED FOR THESE ELEMENTS. WITH THIS SWITCH ON, AN INTERNAL POWER SUPPLY OR AMPLIFIER IS PERMITTED TO WARM UP WITHOUT THE CHART DRIVE OPERATING.

2) SELECT CHART SPEED BY SETTING THE INCHES SELECTOR AND THE HR-MIN-SEC SELECTOR TO THE DESIRED POSITIONS.

NOTE: THE FRONT-PANEL DIAL WILL BE CALIBRATED IN CENTIMETERS INSTEAD OF INCHES FOR ALL METRIC CHART DRIVES.

3) TURN ON CHART DRIVE SWITCH. THIS SUPPLIES EXCITATION TO THE HR-MIN-SEC SELECTOR WHICH, IN TURN, DISTRIBUTES POWER TO THE DRIVE MOTORS. THE REVERSIBLE HOUR-MINUTE MOTOR RUNS CONTINUOUSLY; WHILE THE SECOND-SPEED MOTOR OPERATES ONLY WHEN THE PANEL SELECTOR IS IN THE SEC POSITION. THE CHART WILL NOW BEGIN TO TRAVEL AT THE RATE INDICATED ON THE INCHES KNOB AS RELATED TO THE TIME UNIT SELECTED ON THE HR-MIN-SEC SELECTOR.

4) TO CHANGE CHART SPEED, ROTATE EITHER PANEL SELECTOR TO THE DESIRED POSITION. THESE CONTROLS MAY BE OPERATED AT ANY TIME--WITH POWER ON OR OFF.

5) TO STOP THE CHART PAPER, PLACE THE CHART DRIVE SWITCH IN ITS OFF POSITION.

MANUAL CHANGE GEARS

ON THE 300 AND 318 MODULES, IT IS NECESSARY TO MANUALLY CHANGE THE DRIVE GEARS WHEN DIFFERENT CHART SPEEDS ARE REQUIRED. NO DISASSEMBLY IS REQUIRED FOR THE CHANGE EXCEPT THE REMOVAL AND REPLACEMENT OF GEARS. TO CHANGE CHART SPEED, PROCEED AS FOLLOWS:

1) SWING CHART DRIVE MECHANISM OUT TO ITS SERVICE POSITION.

2) CONSULT THE TABLE ON THE TOP OF THE TRANSMISSION ASSEMBLY AND SELECT GEARS FOR THE DESIRED CHART SPEED.

3) REMOVE THE KNURLED LOCKING NUTS FROM THE END OF THE TRANSMISSION ASSEMBLY AND REMOVE GEARS FROM SHAFTS. PRESS NEW GEARS ON SHAFTS AND REINSTALL KNURLED NUTS TIGHTENING ONLY BY HAND. NOTE THE ILLUSTRATION ON THE INSTRUCTION PLATE WHICH SHOWS RELATIVE POSITION OF THE GEARS. GEARS MAY BE IDENTIFIED BY COLOR AND BY THE NUMBER OF GEAR TEETH. SAVE UNUSED GEARS FOR FUTURE USE.

REMOTE CONTROL

AS AN OPTIONAL FEATURE, ALL SERIES "E" CHART DRIVES MAY BE EQUIPPED WITH REMOTE CONTROL. EXTERNAL REMOTE SWITCHES OR CONTACT CLOSURES MAY BE USED TO TURN ON OR TURN OFF THE CHART DRIVE, AS WELL AS TO SELECT HOUR-MINUTE AND HOUR-MINUTE-SECOND FUNCTIONS WHENEVER THEY ARE INCLUDED AS PART OF THE DRIVE SYSTEM. WHEN THE INSTRUMENT IS WIRED FOR REMOTE CONTROL, THE POWER SWITCH MUST BE ON FOR BOTH LOCAL AND REMOTE OPERATION.

A RECORDER EQUIPPED FOR REMOTE CONTROL OPERATION OF THE CHART DRIVE WILL HAVE NUMERICALLY-IDENTIFIED TERMINALS ON THE TERMINAL MOUNTING PLATE ASSEMBLY (SEE FIGURE 3.8 IN PART 3, SECTION II) FOR USE IN MAKING BOTH INTERNAL AND EXTERNAL CONNECTIONS OF THE REMOTE CONTROL SYSTEM.

REMOTE CONTROL OPERATION OF THE CHART DRIVE ALSO REQUIRES A LOCAL-REMOTE SWITCH WHICH IS USED TO SELECT THE MODE OF OPERATION. THIS SWITCH, AT THE OPTION OF THE PURCHASER, MAY BE SUPPLIED AND WIRED INTERNALLY AT THE FACTORY; OR IT MAY BE SUPPLIED AND WIRED EXTERNALLY BY THE PURCHASER. THE POWER WIRING DIAGRAM SHOWING INTERNAL AND EXTERNAL CONNECTIONS FOR REMOTE CONTROL OPERATION OF THE VARIOUS CHART DRIVE MODULES (WITH EITHER INTERNALLY-MOUNTED OR EXTERNALLY-MOUNTED MODE SWITCH) IS FOUND IN FIGURE 2-33.

THE MODE SWITCH AFFORDS COMPLETELY FOOL-PROOF OPERATION. WHEN OPERATING THE CHART DRIVE FROM A REMOTE LOCATION, THE MODE SWITCH IS PLACED IN ITS REMOTE POSITION. THE DRIVE IS THEN CONTROLLED ONLY BY EXTERNAL CONTACT CLOSURE, AND THE INTERNAL SWITCHING WILL HAVE NO EFFECT. CONVERSELY, WHEN OPERATING THE DRIVE AT THE INSTRUMENT, THE MODE SWITCH IS PLACED IN ITS LOCAL POSITION. IN THIS CASE, THE DRIVE IS CONTROLLED ONLY BY THE FRONT PANEL SWITCHES; AND THE EXTERNAL CONTACT CLOSURES WILL HAVE NO EFFECT.

NOTE: MULTIPLE-SPEED DRIVES 303, 309, 321, AND 327 HAVE AN INCHES SELECTOR DIAL WHICH, OF COURSE, MUST BE MANUALLY OPERATED AT THE FRONT PANEL OF THE INSTRUMENT REGARDLESS OF WHETHER THE REMOTE OR LOCAL MODE HAS BEEN SELECTED.

WHEN THE MODE SWITCH IS SUPPLIED AT THE FACTORY, IT IS LOCATED ON THE FRONT PANEL OF ALL CHART DRIVE MODULES EXCEPT THE NO. 327. WHEN THE NO. 327 CHART DRIVE IS EMPLOYED, THE MODE SWITCH WILL BE LOCATED ELSEWHERE WITHIN THE RECORDER CASE.

ALL REMOTE CONTACT-MAKING DEVICES AND EXTERNAL WIRING MUST BE FURNISHED BY THE INSTRUMENT OWNER. THE NUMBER AND TYPE OF EXTERNAL CONTACT CLOSURES REQUIRED WILL DEPEND UPON THE NUMBER OF REMOTE FUNCTIONS DESIRED AND THE NATURE OF THE PARTICULAR INSTALLATION.

THE POWER WIRING DIAGRAMS SHOWING THE INTERNAL CONNECTIONS OF THE VARIOUS CHART DRIVE MODULES (WITH AND WITHOUT REMOTE CONTROL) ARE SHOWN IN PART 2, SECTION III OF THIS MANUAL. THE POWER WIRING INTERCONNECTIONS OF THE CHART DRIVE MODULES WITHOUT REMOTE CONTROL OPERATION ARE FOUND IN THE POWER AND/OR ACCESSORY WIRING DIAGRAM(S) IN PART 3, SECTION III OF THIS MANUAL.

CHART REMOVAL

CHANGING CHARTS PROMPTLY ASSURES CONTINUOUS RECORDS AND ALSO PREVENTS DAMAGE TO COMPONENTS OF THE RECORDER. IF THE WRITING ELEMENT OR ELEMENTS ARE PERMITTED TO COME IN CONTACT WITH THE DRIVE ROLL, INK MAY FLOW ON THE ROLLER AND THE TIP OF THE WRITING ELEMENT MAY BECOME IMPAIRED.

REMOVAL PROCEDURES

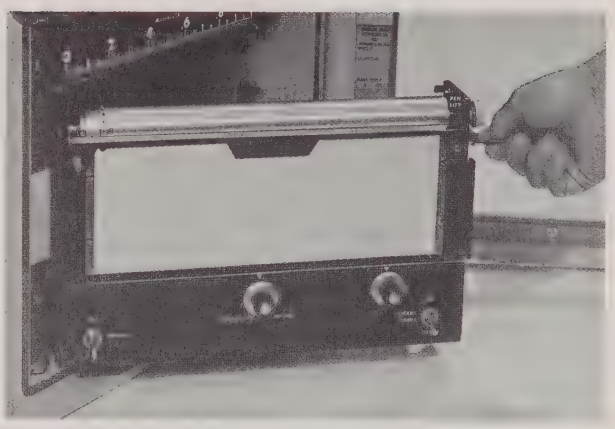


FIGURE 2.13. OPEN CASE DOOR, TURN OFF POWER, PRESS DOWN ON LEVER AT TOP-RIGHT OF CHART TRANSPORT, AND SWING OUT TRANSPORT TO LOADING POSITION AS SHOWN.

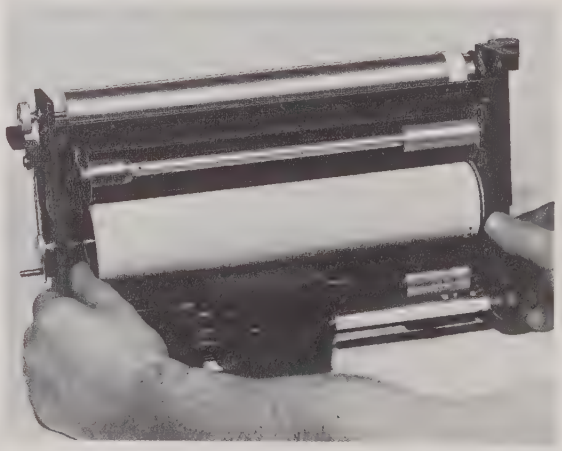


FIGURE 2.14. PUSH DOWN ON CLIP AT EACH END OF REROLL CYLINDER AND REMOVE REROLLED CHART AND CYLINDER FROM INSTRUMENT.

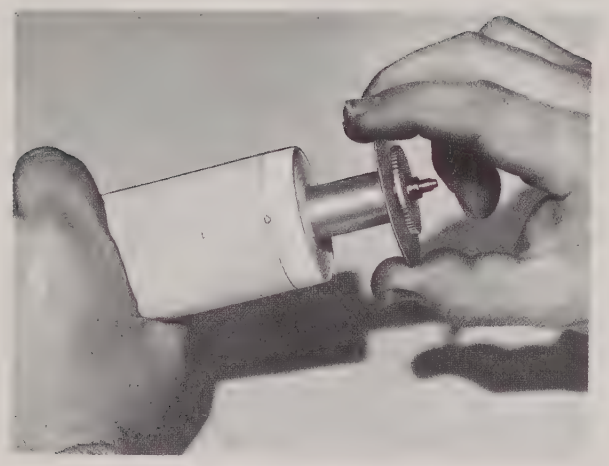


FIGURE 2.15. CAREFULLY REMOVE EACH END SECTION OF CYLINDER FROM CENTER OF PAPER ROLL. IF PAPER IS TOO TIGHTLY WOUND, TWIST CYLINDER AS IT IS WITHDRAWN.

FIGURE 2.16. TELESCOPE CYLINDER SECTIONS TOGETHER, ALIGN SLOTS IN BOTH SECTIONS, AND SNAP CYLINDER BACK INTO TRANSPORT. SEE CHARTING PROCEDURES TO INSTALL CHART.

RECORDING CHARTS

TO MAINTAIN INSTRUMENT ACCURACY AND INSURE OPTIMUM PERFORMANCE, ONLY ESTERLINE ANGUS PRECISION CHARTS SHOULD BE USED WITH THIS RECORDER. STANDARD SERIES "E" CHARTS HAVE THREE SETS OF TIME NUMBERS IMPRINTED UPON THEM. THE TIME NUMBERS APPEARING AT THE CENTER OF THE CHART ARE FOR 1" PER HOUR SPEEDS AND ARE MARKED A.M. AND P.M. THE TIME NUMBERS APPEARING IN THE LEFT PORTION OF THE CHART ARE FOR 2" PER HOUR SPEEDS AND THOSE IN THE RIGHT PORTION OF THE CHART ARE FOR 3" PER HOUR SPEEDS. TIME NUMBERS APPEAR EVERY 1, 2, AND 3 INCHES ON THE 120-FT. CHARTS. ESTERLINE ANGUS 11" CHARTS MAY ALSO BE ORDERED WITH SPECIAL RULINGS, RANGES, CAPTIONS, AND TIME NUMBERS. CONSULT THE FACTORY FOR SPECIAL REQUIREMENTS.

THE CHART RECORD MAY BE INSPECTED AT ANY TIME DURING OPERATION BY UNWINDING THE PAPER FROM THE TAKE-UP ROLLER. WITH THE CHART DRIVE IN OPERATION, THE TAKE-UP SYSTEM FUNCTIONS AT ALL TIMES AND WILL QUICKLY REROLL ANY PORTION OF THE CHART UNWOUND FOR INSPECTION. IF DESIRED, THE REROLL ACTION MAY BE SPEEDED UP WITHOUT THROWING THE CHART OUT OF TIME BY MANIPULATING THE KNOB ON THE RIGHT END OF THE REROLL CYLINDER.

ONLY THE KNOB ON THE DRIVE ROLL SHOULD BE USED TO ADVANCE (OR SET TO TIME) THE CHART PAPER. TO ASSURE A FASTER REROLL ACTION WHEN ADVANCING THE CHART MANUALLY, SELECT A REASONABLY FAST CHART SPEED WHENEVER ONE IS AVAILABLE.

IF THE CHART IS TO BE SET BACKWARDS, THE CLUTCH IN THE DRIVE ROLL WILL INVARIABLY SLIP. THIS IS HARMLESS, BUT THE OPERATOR MUST TAKE UP THE SLACK ON THE SUPPLY ROLL. NO ATTEMPT SHOULD BE MADE TO TURN THE DRIVE ROLL BY PULLING ON THE PAPER BECAUSE HOLES IN THE PAPER WILL ALMOST INVARIABLY TEAR OUT BEFORE FRICTION OF THE MECHANISM IS OVERCOME.

INSTEAD OF HAVING THE CHART PAPER TAKEN UP ON THE BUILT-IN REROLL, IT MAY BE FED OVER THE WRITING TABLE AND STRAIGHT OUT OF THE INSTRUMENT. IF FEEDING DIFFICULTIES ARE ENCOUNTERED AT FAST CHART SPEEDS, IT MAY BE NECESSARY TO ATTACH A 5- OR 6-OUNCE WEIGHT TO THE LEADING EDGE OF THE PAPER AND PERMIT THE PAPER TO FALL FREELY FROM THE INSTRUMENT.

Do not pull or jerk on the chart, as this may either throw it out of time or disengage it from the pins on the drive roll. The bar across the top of the writing table may be used as a tear off edge by pulling the chart straight up from one side to the other.

To help insure a continuous record, Series "E" charts are marked with the number of feet remaining at every 12 inches on the chart in the right hand margin. When 10 feet of chart remain, a note on the chart so indicates. When only three feet of chart is left, THE END is clearly printed across the chart.

Always keep enough Esterline Angus charts on hand to operate the recorder for at least one month. By purchasing in quantities, savings can be realized. Charts must be ordered by assigned numbers, which are printed every six inches on the margin of the chart.

SECTION III - MAINTENANCE

GENERAL

The Chart Drive module employed in this recorder is of sturdy construction and is designed for long trouble-free operation. Nevertheless, it should receive the care afforded any precision piece of equipment to extend its useful life. Periodic maintenance schedules should be established and followed to insure optimum performance of the instrument. These schedules should include inspection, cleaning, adjustments, and lubrication. Time intervals between regularly scheduled maintenance operations will vary according to the frequency of use and environmental conditions. Maintenance scheduling is therefore left entirely up to the discretion of the user. Where extreme temperatures or contaminated atmospheres prevail, the user should adopt a more frequent schedule.

> WARNING: To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

INSPECTION

A complete visual inspection of the chart drive should be made at each maintenance period in order to detect the possible onset of a malfunction. Particular attention should be paid to the following:

1) Accumulation of dirt or other foreign bodies within the mechanism.

2) Loose screws, couplings, nuts and other hardware.

3) Misalignment of gears, shafts, arms, etc.

4) Evidence of excessive wear in moving parts.

5) Damaged wiring and loose connections.

6) Missing or damaged tensioning springs (321 and 327 only).

If a fault is evident from any of the above possible troubles, proper corrective measures should be instituted without delay.

CLEANING

Dirt, dust, or other foreign bodies are not conducive to long life of working parts, and precautions should be taken to prevent admission of these substances into the chart drive assemblies. Regardless of the precautions taken, dirt will enter the case; therefore, the chart drive should be cleaned periodically.

Remove chart paper, roller cylinders, cover plates, and front control panel before cleaning. All surfaces should be carefully cleaned using a soft bristled brush or low vacuum system. Mild soap or detergent may be used to clean the writing table, control panel, and the outer surfaces of the roller cylinders.

> CAUTION: Do not disturb mechanical alignment of parts or routing of wiring during cleaning procedures.

Ink or other liquids, if spilled on the chart drive mechanism, should be removed promptly with appropriate means. EA recording ink is water-based and may be removed with a wet cloth. Other liquids must be removed by means appropriate to their nature. Dirt may be removed, especially when lodged in lubricating grease by use of a suitable brush and a mild solvent--such as benzine. Harsh solvents such as acetone or paint brush reconditioners should not be employed because of possible damage to plastics. When a solvent has been used, parts should be allowed to dry thoroughly before a lubricant is applied.

> CAUTION: Do not use excessive amounts of cleaning solvents on oil-impregnated bearings.

ADJUSTMENTS

Although all Esterline Angus chart drives are carefully adjusted for high standards of operation before leaving the factory, the following field adjustments are made possible to satisfy special applications and as a preventive maintenance measure.

CHART TENSION--FOR OPTIMUM CHART DRIVE OPERATION, THE CHART PAPER MUST HAVE A REGULATED AMOUNT OF TENSION APPLIED TO IT AT ALL TIMES, THE PAPER MUST NOT BE TOO LOOSE SO THAT IT SAGS, AND IT MUST NOT BE DRAWN TOO TIGHT SO THAT IT WRINKLES OR TEARS. THE DRIVE ROLL PROPELS THE PAPER AT AN ACCURATE RATE OF SPEED WHILE PROPER TENSION IS MAINTAINED BY TWO SEPARATE CLUTCH ASSEMBLIES: ONE IN THE REROLL CYLINDER AND ONE IN THE SUPPLY ROLL STICK. THESE CLUTCHES ARE ADJUSTED AS FOLLOWS:

> CAUTION: DO NOT ATTEMPT TO ADJUST CLUTCHES UNLESS TROUBLE HAS BEEN TRACED TO THIS POSSIBLE SOURCE.

REMOVE THE REROLL CYLINDER FROM THE CHART TRANSPORT, TURN SET SCREW INTO THE CYLINDER AT ITS GEARED END, AND WITHDRAW THE END FLANGE ASSEMBLY (SEE FIGURE 2.17). ADJUST CLUTCH TENSION BY TURNING THE ADJUSTING NUT IN THE DIRECTION REQUIRED.

IF CLUTCH TENSION IS TOO GREAT, THE CHART PAPER MAY START TO WRINKLE AS IT LEAVES THE DRIVE ROLL. IN EXTREME CASES, THE PAPER MAY EVEN TEAR AT THE BACK EDGE OF THE DRIVE ROLL PINS. IF THERE IS NOT ENOUGH TENSION, THE PAPER MAY TEND TO SAG AND NOT WRAP PROPERLY ON THE REROLL CYLINDER. THESE CONDITIONS WILL NOT EXIST WHEN THE REROLL CLUTCH IS CORRECTLY ADJUSTED. AFTER PROPER TENSION IS ACHIEVED, REPLACE THE FLANGE ASSEMBLY, TURN SET SCREW OUT SO THAT IT IS FLUSH WITH THE SURFACE OF THE CYLINDER, AND THEN CHECK OPERATION.

REMOVE THE SUPPLY ROLL STICK FROM THE TRANSPORT, TURN SET SCREW IN, AND WITHDRAW THE END FLANGE ASSEMBLY FROM THE STICK. ADJUST CLUTCH TENSION BY TURNING THE ADJUSTING NUT IN THE DIRECTION REQUIRED (SEE FIGURE 2.17).

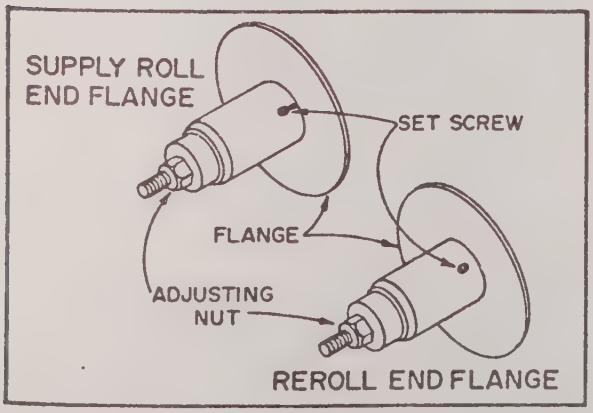


FIGURE 2.17. END FLANGE ASSEMBLY SHOWING PAPER TENSION ADJUSTMENT.

IF CLUTCH DRAG TENSION IS TOO GREAT, THE CHART PAPER MAY TEND TO TEAR AT THE LEADING EDGES OF THE DRIVE ROLL PINS. IF TENSION IS TOO LITTLE, THE PAPER MAY NOT LAY FLAT ACROSS THE TOP OF THE DRIVE ROLL AND, IN SOME CASES, THE PAPER MAY EVEN SKIP OVER THE DRIVE ROLL PINS. THESE CONDITIONS WILL NOT EXIST WHEN THE SUPPLY ROLL CLUTCH IS CORRECTLY ADJUSTED. AFTER PROPER TENSION IS ACHIEVED, REPLACE THE FLANGE ASSEMBLY, TURN SET SCREW OUT (SET SCREW PROTRUSION SHOULD BE APPROXIMATELY .010" ABOVE SURFACE OF CYLINDER), AND CHECK OPERATION.

CHART WEAVE--FOR OPTIMUM CHART DRIVE OPERATION, LATERAL MOVEMENT OF THE DRIVE ROLL MUST BE LIMITED IN ORDER TO KEEP THE CHART PAPER FROM WEAVING FROM SIDE-TO-SIDE. ALTHOUGH THIS END-SHAKE ADJUSTMENT HAS BEEN PRECISELY SET AT THE FACTORY, READJUSTMENT MAY BECOME NECESSARY IN THE FIELD IF THE SET SCREW IN THE DRIVE ROLL AND/OR THE SET SCREW IN THE DRIVE ROLL GEAR AND HUB ASSEMBLY HAD BEEN PREVIOUSLY LOOSENED DURING SERVICING; OR UNDUE FORCE HAS BEEN EXERTED UPON EITHER THE DRIVE ROLL OR ITS MANUAL ADJUST KNOB.

IF END SHAKE IS TOO GREAT, THE ROLLER WILL DRIFT BACK AND FORTH DURING OPERATION AND CAUSE THE PAPER TO WEAVE. IF THE ADJUSTMENT IS SET TOO TIGHT, THE ROLLER WILL NOT TURN FREELY--THUS PLACING AN EXCESSIVE LOAD UPON THE DRIVING SOURCE. DRIVE ROLL END SHAKE IS ADJUSTED AS FOLLOWS:

1) OPEN CASE DOOR, TURN OFF POWER, AND SWING OUT CHART DRIVE TO SERVICE POSITION.

2) LOOSEN #6-32 SET SCREW ON RIGHT-HAND END OF DRIVE ROLL. SEE FIGURE 2.18.

3) LATERALLY MOVE DRIVE ROLL TO THE LEFT SO THAT THE HUB OF THE GEAR AT THE LEFT OF THE DRIVE ROLL BUTTS AGAINST THE LEFT-HAND SIDE PLATE. MEASURE DISTANCE BETWEEN LEFT-HAND SIDE PLATE AND CENTER LINE OF PINS ON DRIVE ROLL. THIS DISTANCE SHOULD MEASURE APPROXIMATELY 1.093" (1 3/32") AS SHOWN IN FIGURE 2.18. IF THIS DIMENSION IS OFF, LOOSEN #4-40 SET SCREW IN GEAR HUB. HOLD HUB AGAINST LEFT-HAND SIDE PLATE AND LATERALLY POSITION DRIVE ROLL TO OBTAIN THE 1.093" DIMENSION. THEN TIGHTEN SET SCREW IN GEAR HUB.

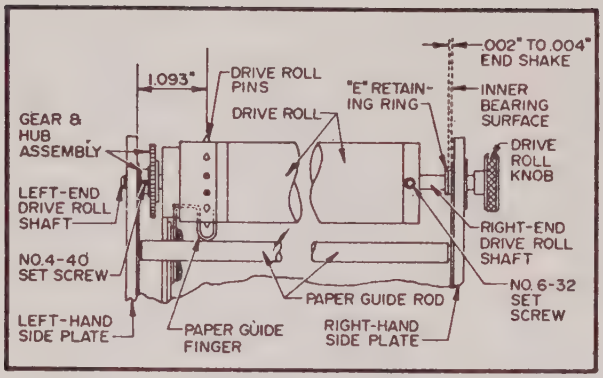


FIGURE 2.18. PART OF TRANSPORT ASSEMBLY SHOWING END-SHAKE ADJUSTMENT.

4) LATERALLY POSITION DRIVE ROLL SO THAT GEAR HUB BUTTS AGAINST LEFT-HAND SIDE PLATE. PULL DRIVE ROLL KNOB OUTWARD UNTIL RETAINING RING ON KNOB SHAFT SEATS AGAINST INNER BEARING SURFACE OF RIGHT-HAND SIDE PLATE.

5) CAREFULLY TAP KNOB INWARD UNTIL A CLEARANCE OF APPROXIMATELY .002" TO .004" IS OBTAINED BETWEEN SHAFT RETAINING RING AND INNER BEARING SURFACE AS SHOWN IN FIGURE 2.18.

NOTE: A THIN PIECE OF PAPER MAY BE USED AS A SHIM GAUGE FOR THIS OPERATION.

6) TIGHTEN DRIVE ROLL SET SCREW AGAINST KNOB SHAFT AND CHECK OPERATION.

LUBRICATION

THE CHART DRIVE MECHANISM SHOULD BE LUBRICATED AT REGULARLY SCHEDULED INTERVALS, BUT ONLY WITH LUBRICANTS RECOMMENDED IN THIS MANUAL. ALWAYS CLEAN THE PART OR ASSEMBLY BEFORE LUBRICATING. DO NOT OVER LUBRICATE--ALWAYS WIPE OFF EXCESSIVE OIL AND GREASE BEFORE EXPOSING THE INSTRUMENT TO DIRT LADEN ATMOSPHERES.

LUBRICATION POINTS ARE SHOWN IN FIGURE 2.19. UNDER NORMAL OPERATING CONDITIONS BEARING SHAFTS AND CLIPS OF ROLLERS, THE TRANSPORT LATCH, AND ALL HINGES AND PIVOT POINTS SHOULD BE OILED ONCE EVERY SIX MONTHS. ALL GEAR TEETH SHOULD BE GREASED EVERY 12 MONTHS. THE BRONZE BEARINGS WHICH ARE PRESSED INTO THE SIDE PLATES OF THE VARIOUS ASSEMBLIES ARE OIL IMPREGNATED AND WILL REQUIRE LITTLE LUBRICATION. IF CLEANING SOLVENTS ARE USED, HOWEVER, THESE BEARINGS SHOULD BE RELUBRICATED ONCE EVERY 15 TO 18 MONTHS.

THE REVERSIBLE SYNCHRONOUS MOTOR[1] MAY BE OILED THROUGH A SMALL HOLE IN ITS CASE; THIS HOLE IS ACCESSIBLE BY SWINGING THE DRIVE OUTWARD AND REMOVING THE PLASTIC PLUG FROM THE TOP OF THE DRIVE MODULE PLATE (FIGURE 2-19). LUBRICATE THE YELLOW HOLE IN THE MOTOR WITH 20 DROPS OF OIL EVERY THREE MONTHS FOR NORMAL DUTY (8 HOURS/DAY, 5-DAY WEEK); OR MORE FREQUENTLY IF AMBIENT TEMPERATURES REMAIN ABOVE 104°F. FOR MORE CONTINUOUS DUTY, ADD OIL AFTER EVERY 2000 RUNNING HOURS.

THE SYNCHRONOUS MOTOR EMPLOYED FOR THE FASTER, SECOND CHART SPEEDS (DRIVE NO. 327) IS PERMANENTLY LUBRICATED AT THE FACTORY AND WILL NOT REQUIRE FURTHER ATTENTION IN THE FIELD.

RECOMMENDED OIL LUBRICANTS ARE AS FOLLOWS:

STANOIL #35 (MANUFACTURED BY STANDARD OIL-DIV. AMER.) OR EQUIVALENT.

GULF HARMONY 53 (MANUFACTURED BY GULF OIL CO.) OR EQUIVALENT.

RECOMMENDED GREASE LUBRICANTS ARE AS FOLLOWS:

BEACON 325 (MANUFACTURED BY HUMBLE OIL CO.) OR EQUIVALENT.

DISASSEMBLY

TO REMOVE THE ENTIRE CHART DRIVE ASSEMBLY FROM THE INSTRUMENT CASE, PROCEED WITH THE FOLLOWING STEPS:

WARNING: ALWAYS REMOVE POWER FROM INSTRUMENT BEFORE DISASSEMBLING OR SERVICING.

1) OPEN CASE DOOR AND SWING OUT CHART DRIVE AND RECORDING SYSTEM (IF RECORDING SYSTEM ALSO IS A HINGED MODULE).

2) DISCONNECT CHART DRIVE WIRING FROM TERMINAL CONNECTIONS IN CASE.

3) LOOSEN WIRING CABLE CLAMPS IN CASE.

4) REMOVE RETAINING RINGS FROM HINGE PINS AND PUSH PINS UP OR DOWN TO CLEAR CHART DRIVE PORTION OF HINGE.

CAUTION: DO NOT COMPLETELY REMOVE HINGE PINS IF RECORDING SYSTEM IS ALSO A HINGED MODULE.

5) WHEN PINS ARE CLEAR, CAREFULLY REMOVE

[1] IN LATER PRODUCTION UNITS, ALL CHART DRIVE MOTORS USED ARE OF THE PERMANENTLY-LUBRICATED TYPE AND DO NOT REQUIRE ANY ADDITIONAL LUBRICATION IN THE FIELD. THESE LATER PRODUCTION UNITS ARE NO LONGER PROVIDED WITH THE OILING ACCESS HOLES AND THE PLASTIC PLUG BUTTONS PREVIOUSLY LOCATED IN THE TOP OF THE DRIVE MODULE PLATE.

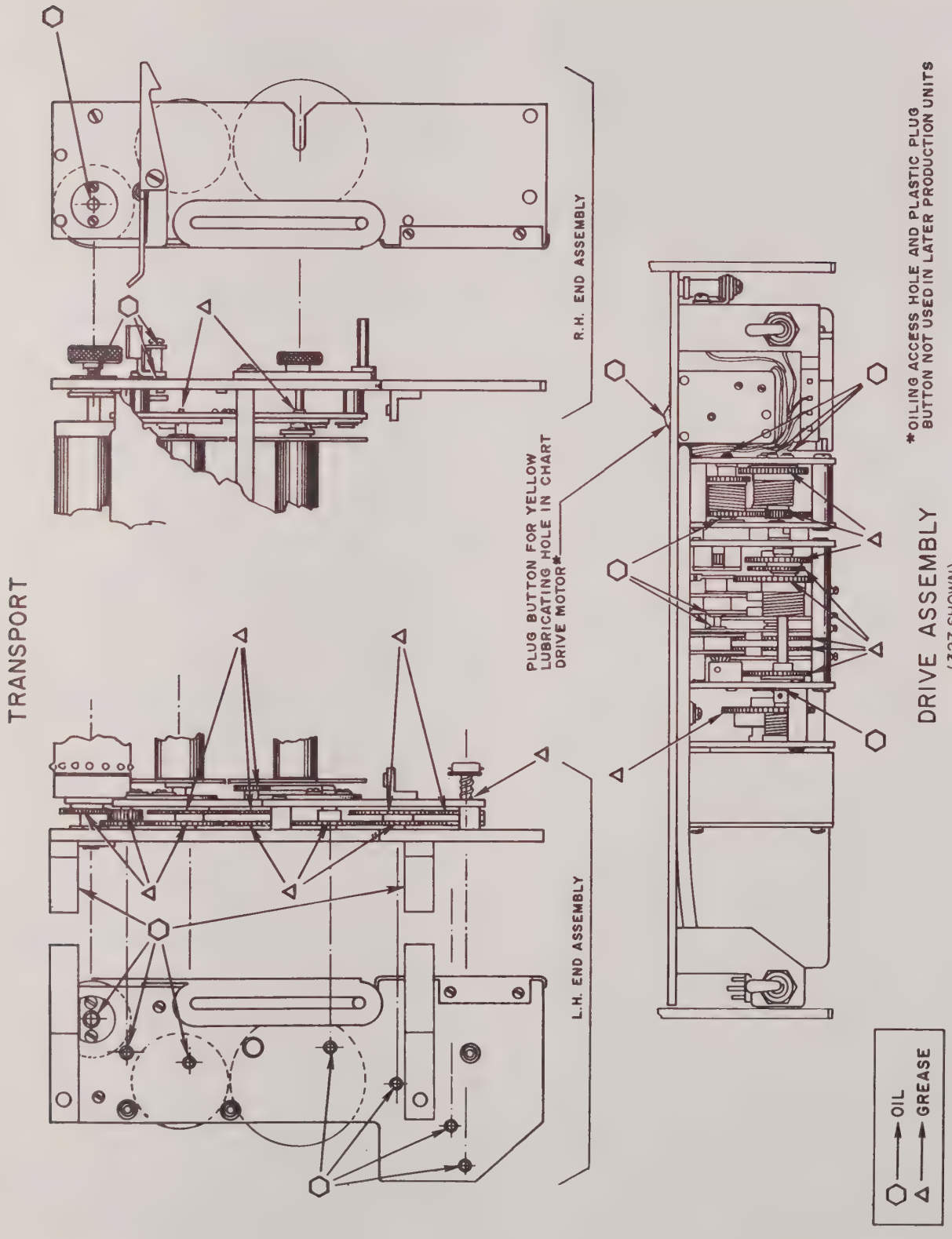

TRANSPORT
R.H. END ASSEMBLY
PLUG BUTTON FOR YELLOW LUBRICATING HOLE IN CHART DRIVE MOTOR*
L.H. END ASSEMBLY
DRIVE ASSEMBLY
(327 SHOWN)
*OILING ACCESS HOLE AND PLASTIC PLUG BUTTON NOT USED IN LATER PRODUCTION UNITS
OIL
GREASE

FIGURE 2.19. CHART DRIVE LUBRICATION POINTS.

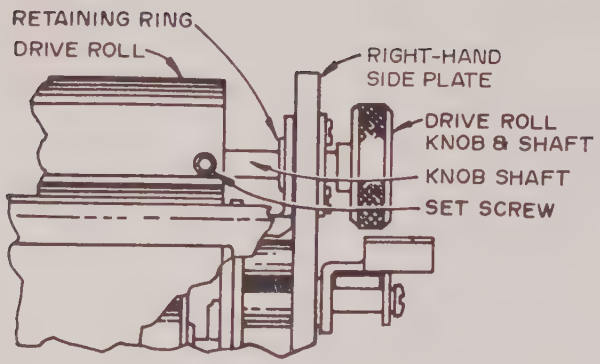


FIGURE 2.20. REMOVING DRIVE ROLL.

ENTIRE CHART DRIVE ASSEMBLY FROM CASE HINGE BLOCK.

DRIVE ROLL--TO REMOVE THE DRIVE ROLL FROM THE TRANSPORT ASSEMBLY, REFER TO FIGURE 2.20 AND PROCEED WITH THE FOLLOWING STEPS:

1) LOOSEN SET SCREW (6-32 HEX-SOCKET) ON RIGHT-HAND END OF DRIVE ROLL.

2) REMOVE RETAINING RING ("E" RING) FROM DRIVE ROLL KNOB SHAFT.

3) PULL OUTWARD ON DRIVE ROLL KNOB, AND REMOVE DRIVE ROLL KNOB AND SHAFT FROM RIGHT-HAND SIDE PLATE.

4) SLIDE DRIVE ROLL TOWARD RIGHT-HAND SIDE PLATE UNTIL SHAFT AT GEARED END OF DRIVE ROLL HAS COMPLETELY WITHDRAWN FROM THE LEFT-HAND SIDE PLATE. LIFT AND REMOVE ENTIRE DRIVE ROLL ASSEMBLY.

CAUTION: BE CAREFUL NOT TO DAMAGE DRIVE-ROLL PINS WHEN REMOVING THE ASSEMBLY.

5) WHEN REINSTALLING THE DRIVE ROLL ASSEMBLY, MAKE SURE THAT THE DRIVE ROLL HAS THE PROPER END-SHAKE ADJUSTMENT. REFER TO END-SHAKE ADJUSTMENT PROCEDURE UNDER "CHART WEAVE."

CONTROL PANEL--THE FRONT CONTROL PANEL FOR THE CHART DRIVE MAY BE REMOVED AS FOLLOWS:

1) LOOSEN SET SCREWS IN FRONT PANEL KNOBS AND REMOVE KNOBS.

2) REMOVE KNURLED SWITCH-RETAINING NUTS FROM FRONT PANEL.

3) REMOVE TWO MACHINE SCREWS FROM EACH END OF CONTROL PANEL.

4) REMOVE PANEL BY PULLING STRAIGHT FORWARD.

DRIVE MODULE--THE ENTIRE DRIVE MODULE (INCLUDING MOTOR(S), TRANSMISSION AND ELECTRICAL COMPONENTS) MAY BE REMOVED FROM THE LOWER PORTION OF THE CHART DRIVE ASSEMBLY AS FOLLOWS:

WARNING: ALWAYS REMOVE POWER FROM INSTRUMENT BEFORE DISASSEMBLING OR SERVICING.

1) REMOVE FRONT CONTROL PANEL.

2) DISCONNECT LEADS FROM TERMINALS WITHIN CASE.

3) LOOSEN WIRING CABLE CLAMPS IN CASE.

4) PUSH DRIVE COUPLING TUBE AGAINST SPRING AT RIGHT END, AND REMOVE TUBE. SEE FIGURE 2.21.

5) REMOVE TWO ASSEMBLY MOUNTING SCREWS FROM EACH END OF DRIVE MODULE.

CAUTION: SUPPORT REVERSIBLE MOTOR WHEN ASSEMBLY MOUNTING SCREWS ARE REMOVED FROM END OF MOTOR.

6) LIFT THE DRIVE MODULE AND SLIDE IT FORWARD AND AWAY FROM THE CHART TRANSPORT.

MOTOR-TRANSMISSION--THE MOTOR-TRANSMISSION ASSEMBLY MAY BE REMOVED FROM THE DRIVE MODULE BY REFERRING TO FIGURE 2.21 AND PROCEEDING WITH THE FOLLOWING STEPS:

1) REMOVE ENTIRE DRIVE MODULE FROM CHART DRIVE ASSEMBLY.

2) REMOVE COVER(S) FROM TERMINAL STRIP(S) ON DRIVE MODULE AND UNSOLDER MOTOR LEADS.

3) Remove two transmission mounting screws pointed out in Figure 2.21.

4) Carefully remove motor-transmission assembly from mounting plate.

DRIVE MOTORS--The chart drive motor or motors may be removed from the motor-transmission assembly by referring to Figure 2.21 and proceeding with the following steps:

1) Remove entire drive module from chart drive assembly.

2) Remove motor-transmission assembly from drive module.

3) Loosen (6-32 hex-socket) set screw in pinion of motor shaft.

4) Remove two motor mounting screws from side plate of gear box or transmission.

5) Carefully slide motor shaft and pinion assembly out of geared unit.

REPLACEMENT PARTS

All parts for Series "E" chart drives are made available directly from Esterline Angus Instrument Company. When ordering parts, always give part numbers and instrument serial number. Refer to the illustrated parts breakdown in this manual for parts identification.

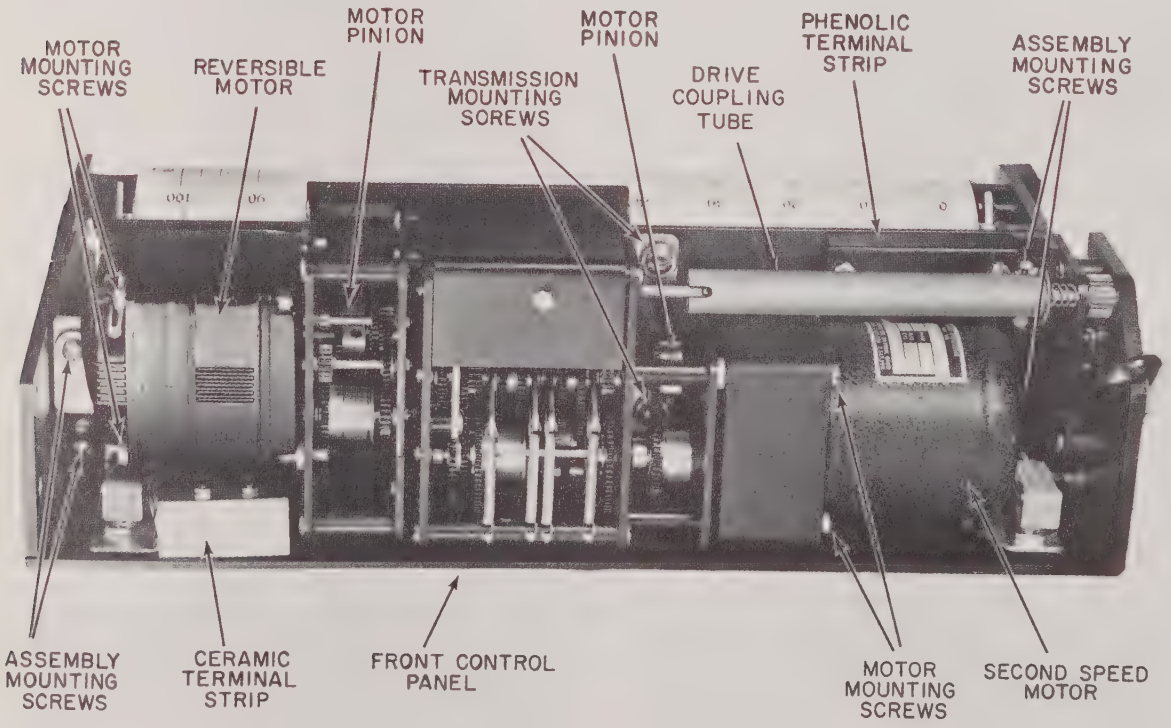
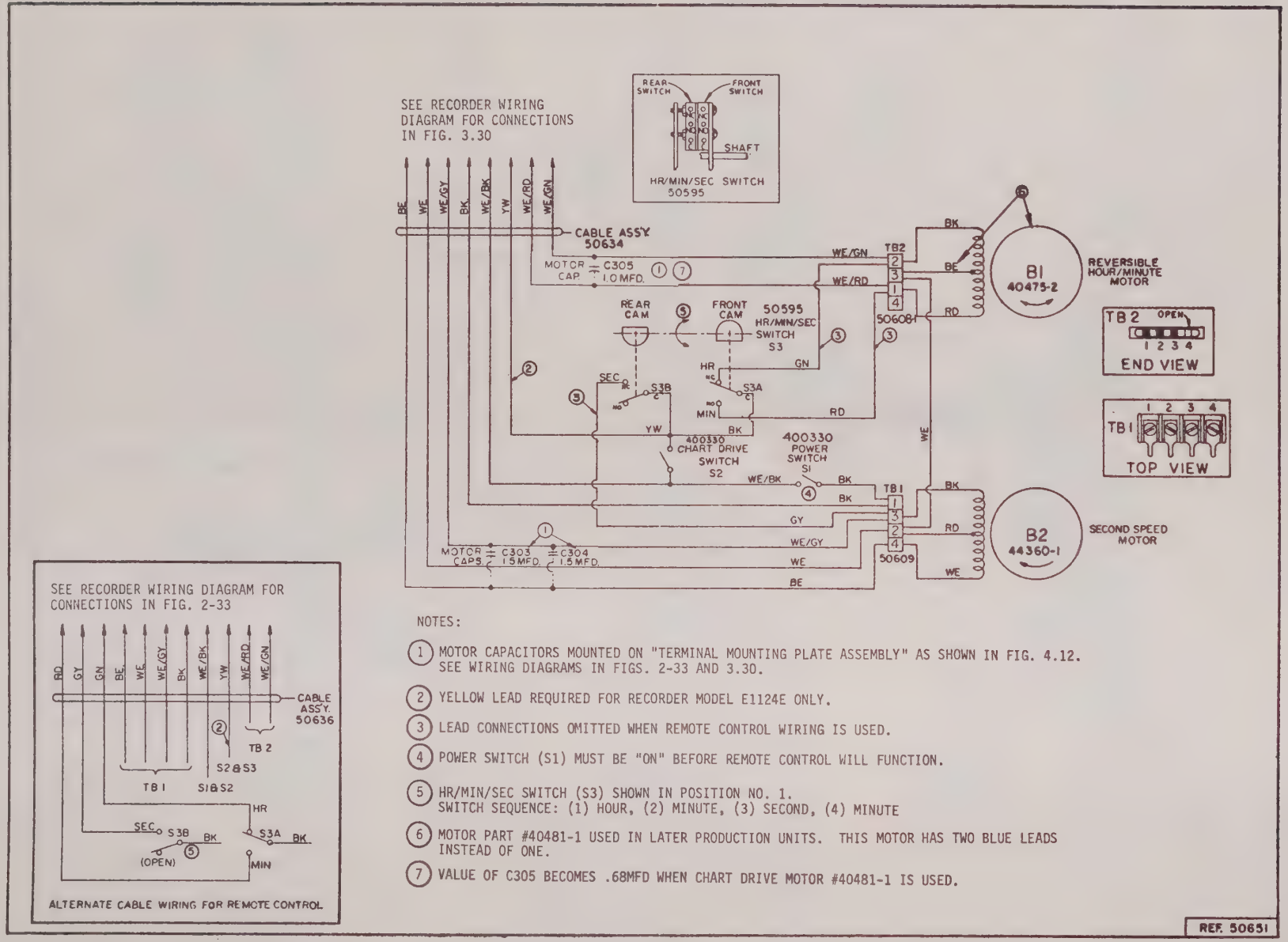


FIGURE 2.21. COMPLETE 327 DRIVE MODULE SHOWING DISASSEMBLY POINTS.



NOTES:

1. MOTOR CAPACITORS MOUNTED ON "TERMINAL MOUNTING PLATE ASSEMBLY" AS SHOWN IN FIG. 4.12. SEE WIRING DIAGRAMS IN FIGS. 2-33 AND 3.30.
2. YELLOW LEAD REQUIRED FOR RECORDER MODEL E1124E ONLY.
3. LEAD CONNECTIONS OMITTED WHEN REMOTE CONTROL WIRING IS USED.
4. POWER SWITCH (S1) MUST BE "ON" BEFORE REMOTE CONTROL WILL FUNCTION.
5. HR/MIN/SEC SWITCH (S3) SHOWN IN POSITION NO. 1. SWITCH SEQUENCE: (1) HOUR, (2) MINUTE, (3) SECOND, (4) MINUTE
6. MOTOR PART #40481-1 USED IN LATER PRODUCTION UNITS. THIS MOTOR HAS TWO BLUE LEADS INSTEAD OF ONE.
7. VALUE OF C305 BECOMES .68MFD WHEN CHART DRIVE MOTOR #40481-1 IS USED.

REF. 50651
P547A

FIGURE 2-26. Power Wiring Diagram for Chart Drive No. 327.

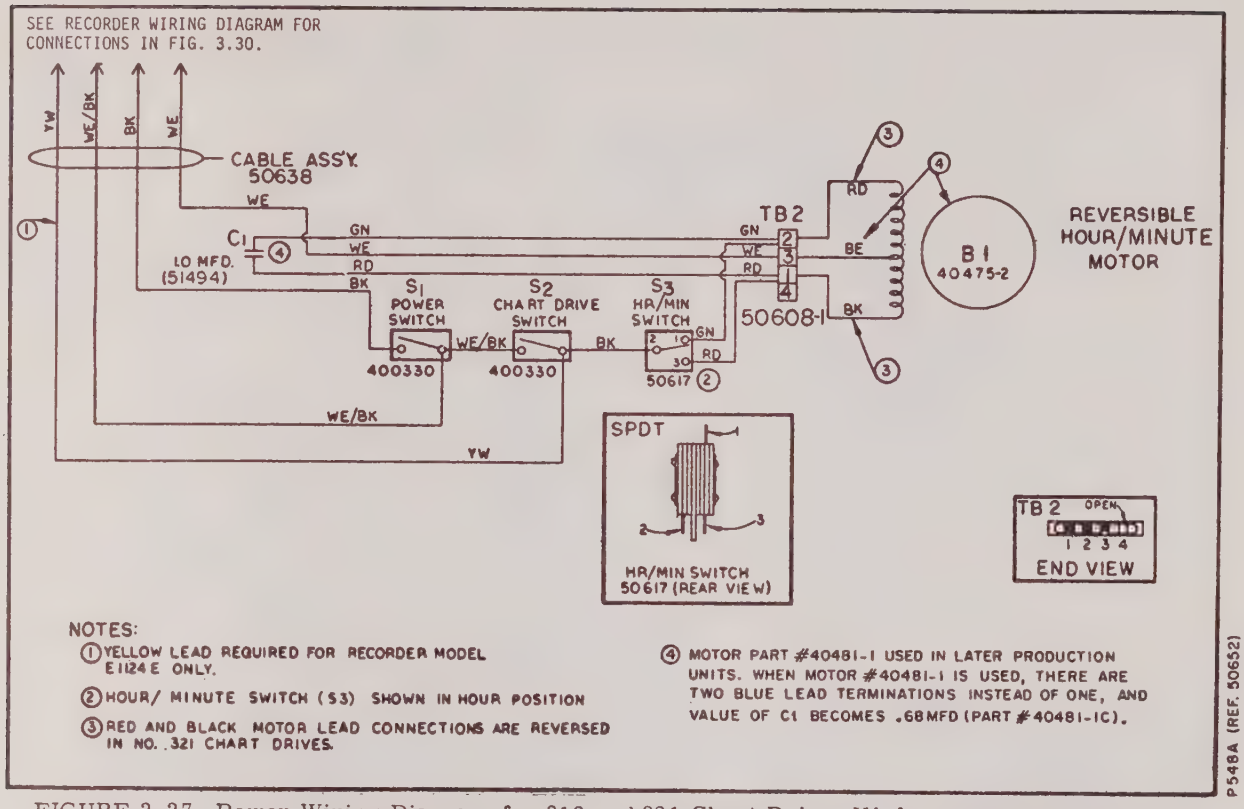

SEE RECORDER WIRING DIAGRAM FOR CONNECTIONS IN FIG. 3.30.
CABLE ASS'Y. 50638
C1
1.0 MFD. (51494)
S1 POWER SWITCH
S2 CHART DRIVE SWITCH
S3 HR/MIN SWITCH
400330
400330
50617
50608-1
TB2
B1 40475-2
REVERSIBLE HOUR/MINUTE MOTOR
SPDT
HR/MIN SWITCH 50617 (REAR VIEW)
TB2 OPEN 1 2 3 4
END VIEW
NOTES:
(1) YELLOW LEAD REQUIRED FOR RECORDER MODEL E1124E ONLY.
(2) HOUR/MINUTE SWITCH (S3) SHOWN IN HOUR POSITION
(3) RED AND BLACK MOTOR LEAD CONNECTIONS ARE REVERSED IN NO. 321 CHART DRIVES.
(4) MOTOR PART #40481-1 USED IN LATER PRODUCTION UNITS. WHEN MOTOR #40481-1 IS USED, THERE ARE TWO BLUE LEAD TERMINATIONS INSTEAD OF ONE, AND VALUE OF C1 BECOMES .68MFD (PART #40481-1C).
P548A (REF. 50652)

FIGURE 2-27. Power Wiring Diagram for 318 and 321 Chart Drives Without Remote Control.

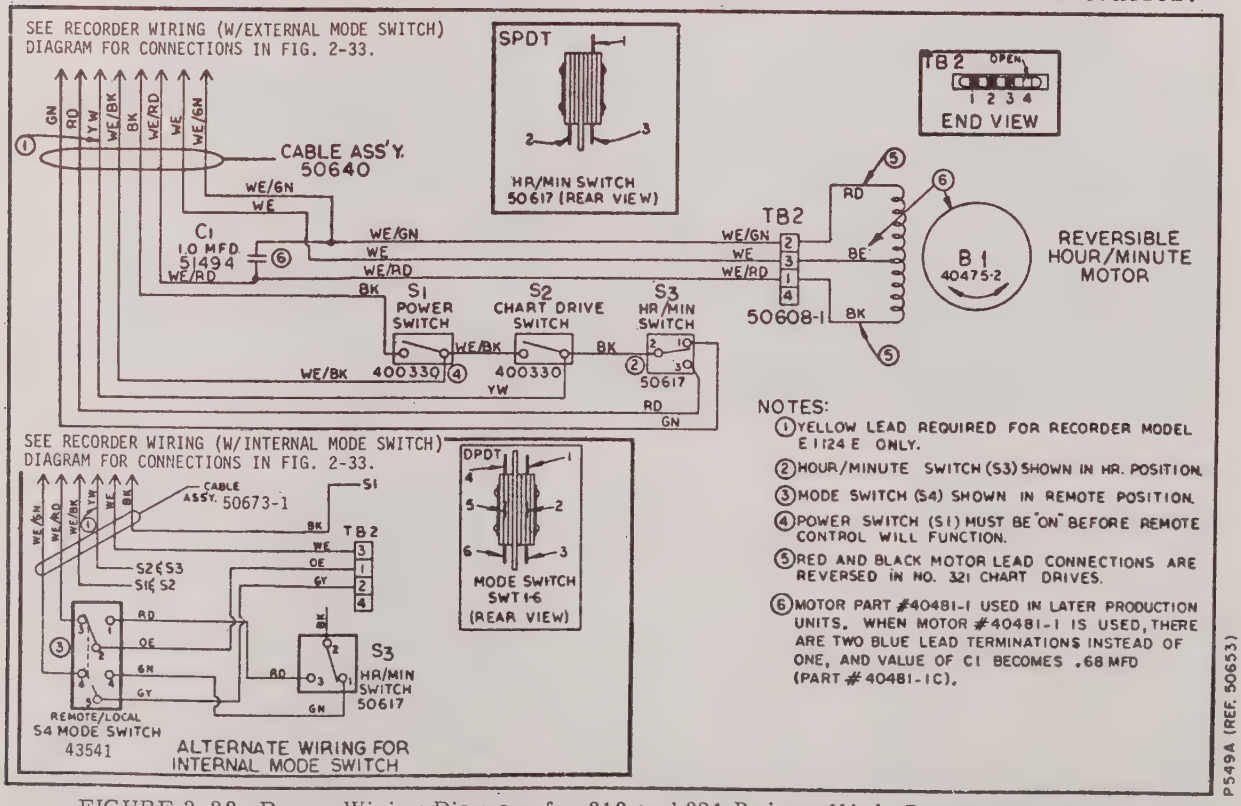

SEE RECORDER WIRING (W/EXTERNAL MODE SWITCH) DIAGRAM FOR CONNECTIONS IN FIG. 2-33.
CABLE ASS'Y. 50640
C1
1.0 MFD. 51494
S1 POWER SWITCH
S2 CHART DRIVE SWITCH
S3 HR/MIN SWITCH
400330
400330
50617
50608-1
TB2
B1 40475-2
REVERSIBLE HOUR/MINUTE MOTOR
SPDT
HR/MIN SWITCH 50617 (REAR VIEW)
TB2 OPEN 1 2 3 4
END VIEW
SEE RECORDER WIRING (W/INTERNAL MODE SWITCH) DIAGRAM FOR CONNECTIONS IN FIG. 2-33.
CABLE ASSY. 50673-1
DPDT
MODE SWITCH SWT 1-6 (REAR VIEW)
REMOTE/LOCAL S4 MODE SWITCH 43541
ALTERNATE WIRING FOR INTERNAL MODE SWITCH
NOTES:
(1) YELLOW LEAD REQUIRED FOR RECORDER MODEL E1124E ONLY.
(2) HOUR/MINUTE SWITCH (S3) SHOWN IN HR. POSITION.
(3) MODE SWITCH (S4) SHOWN IN REMOTE POSITION.
(4) POWER SWITCH (S1) MUST BE "ON" BEFORE REMOTE CONTROL WILL FUNCTION.
(5) RED AND BLACK MOTOR LEAD CONNECTIONS ARE REVERSED IN NO. 321 CHART DRIVES.
(6) MOTOR PART #40481-1 USED IN LATER PRODUCTION UNITS. WHEN MOTOR #40481-1 IS USED, THERE ARE TWO BLUE LEAD TERMINATIONS INSTEAD OF ONE, AND VALUE OF C1 BECOMES .68 MFD (PART #40481-1C).
P549A (REF. 50653)

FIGURE 2-28. Power Wiring Diagram for 318 and 321 Drives With Remote Control.

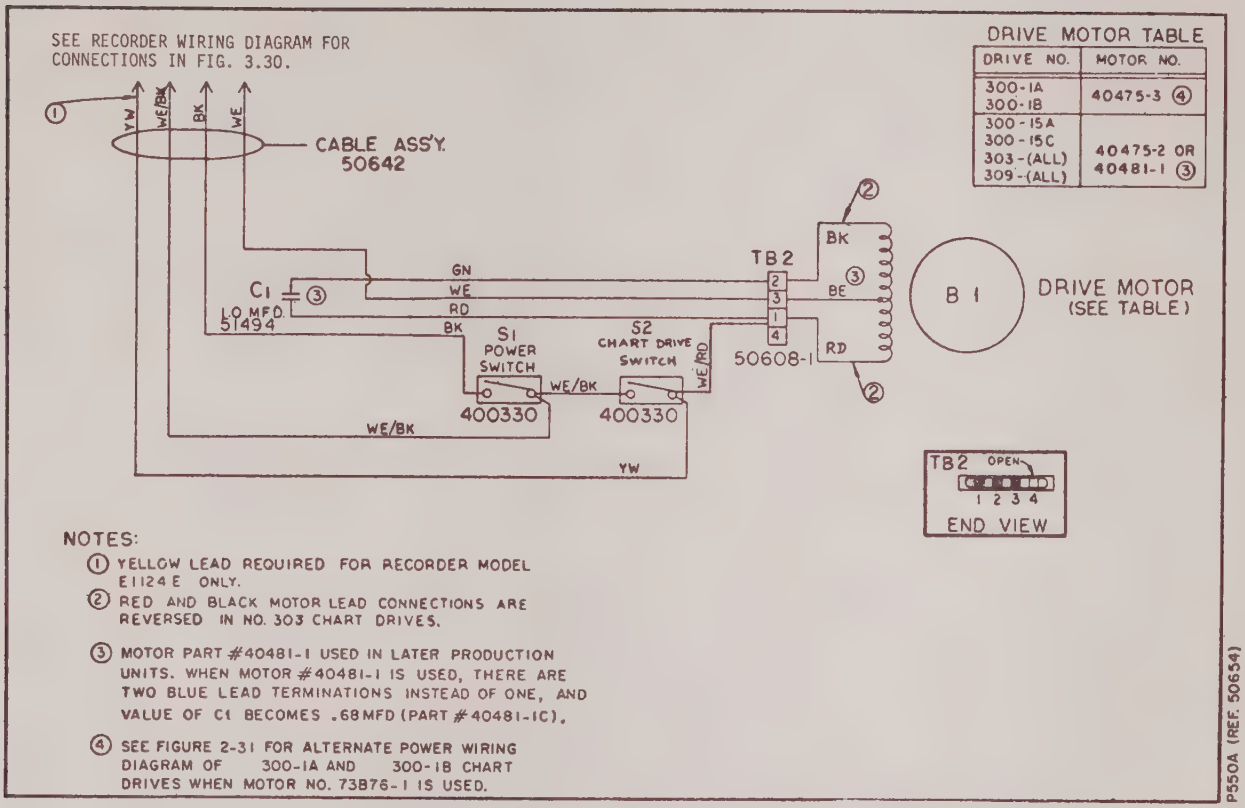


FIGURE 2-29. Power Wiring Diagram for 300, 303 and 309 Chart Drives Without Remote Control.

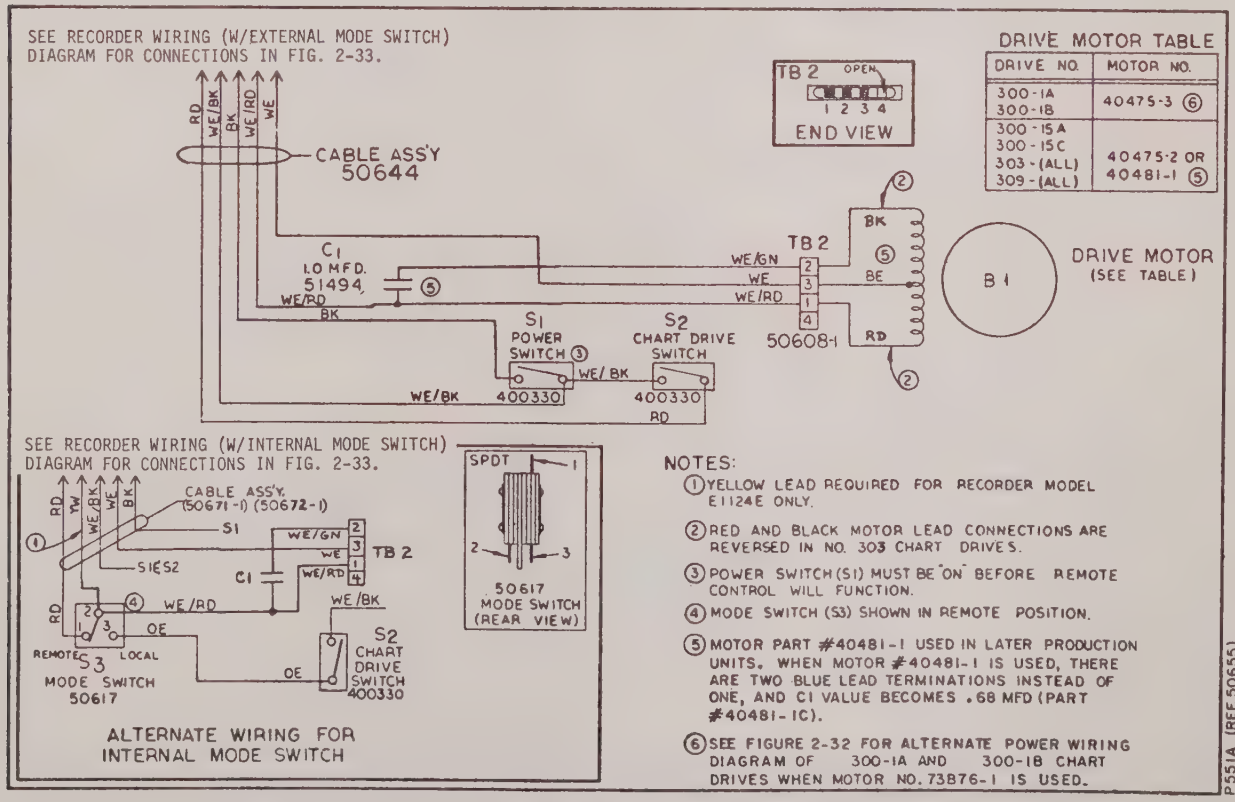


FIGURE 2-30. Power Wiring Diagram for 300, 303 and 309 Chart Drives With Remote Control.

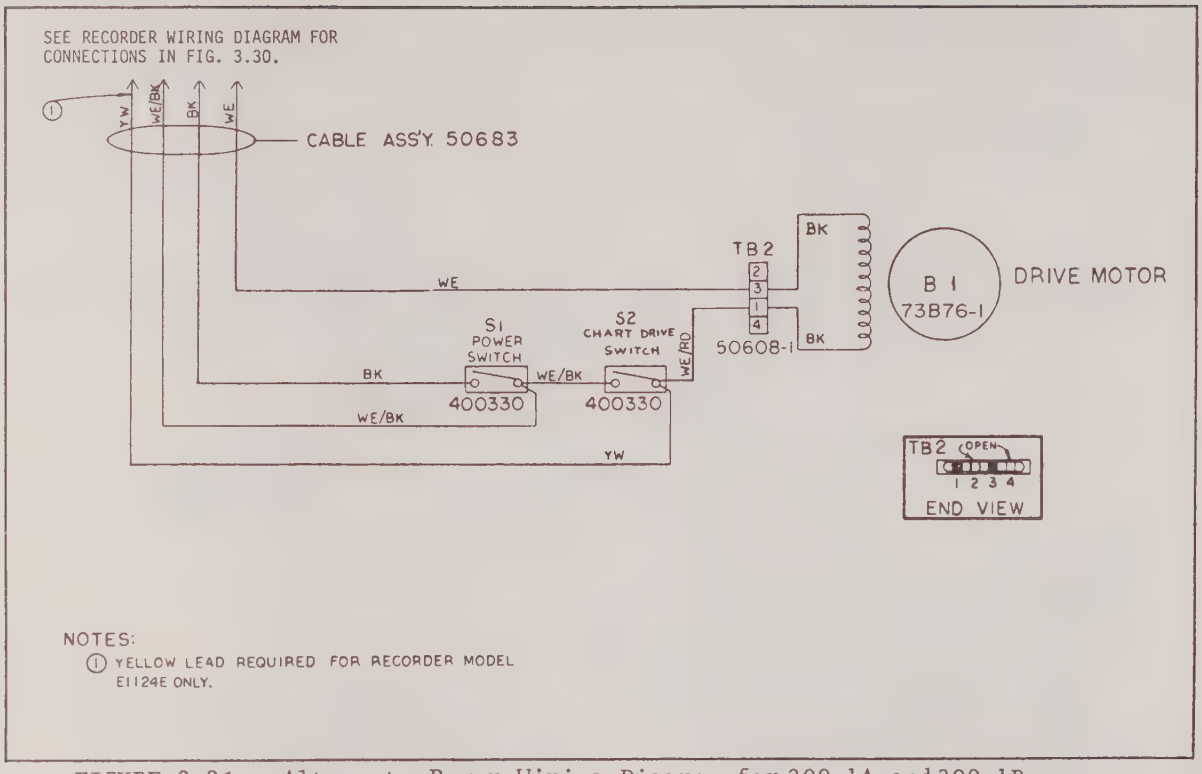


FIGURE 2-31. Alternate Power Wiring Diagram for 300-1A and 300-1B Chart Drives Without Remote Control.

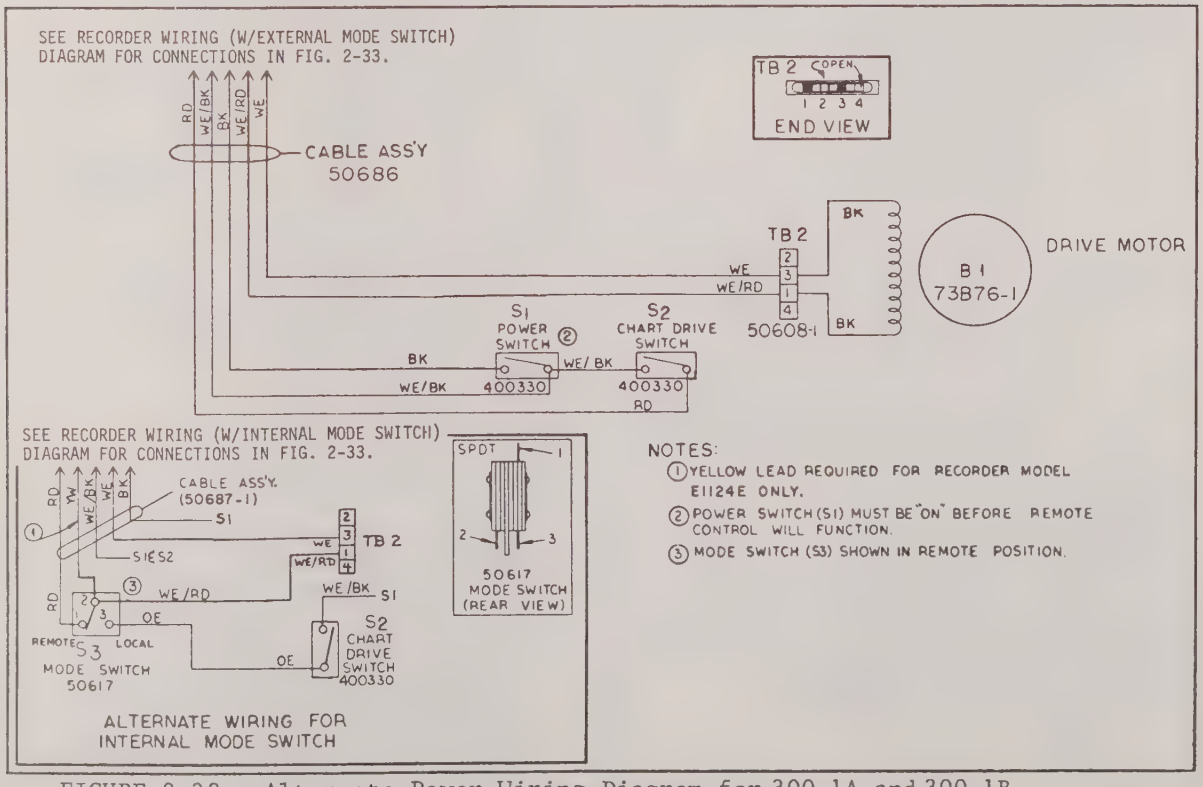
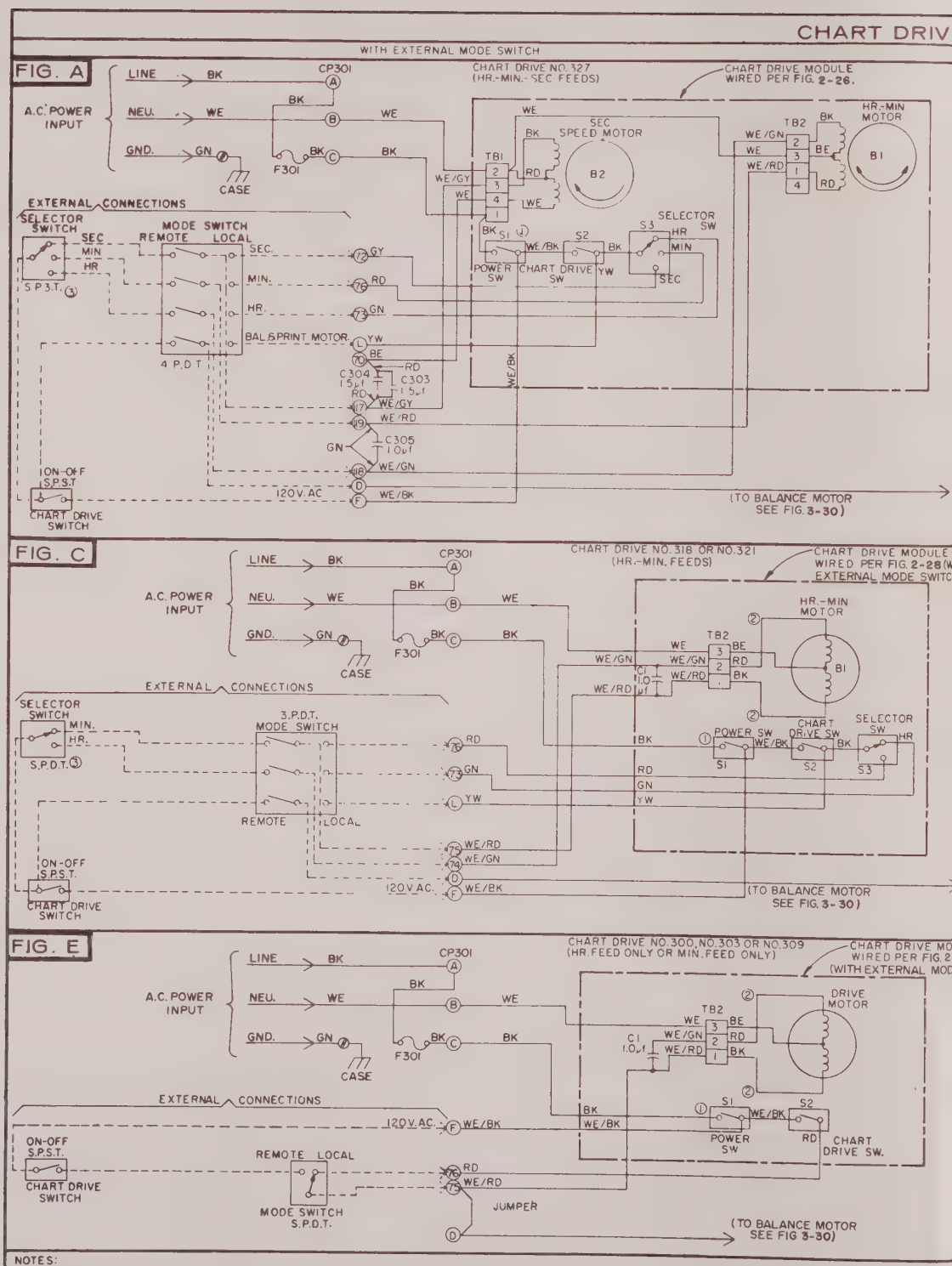


FIGURE 2-32. Alternate Power Wiring Diagram for 300-1A and 300-1B Chart Drives With Remote Control.



NOTES:

① POWER SWITCH (S1) MUST BE "ON" BEFORE REMOTE CONTROL WILL FUNCTION

② RED AND BLACK MOTOR LEAD CONNECTION ARE REVERSED IN NO. 303 & NO. 321 CHART DRIVES.

③ SELECTOR SWITCH MUST HAVE BREAK-BEFORE-MAKE CONTACTS.

④ MODE SWITCH (S302) MOUNTS IN RECORDER CASE.

FIGURE 2-33. POWER WIRIN

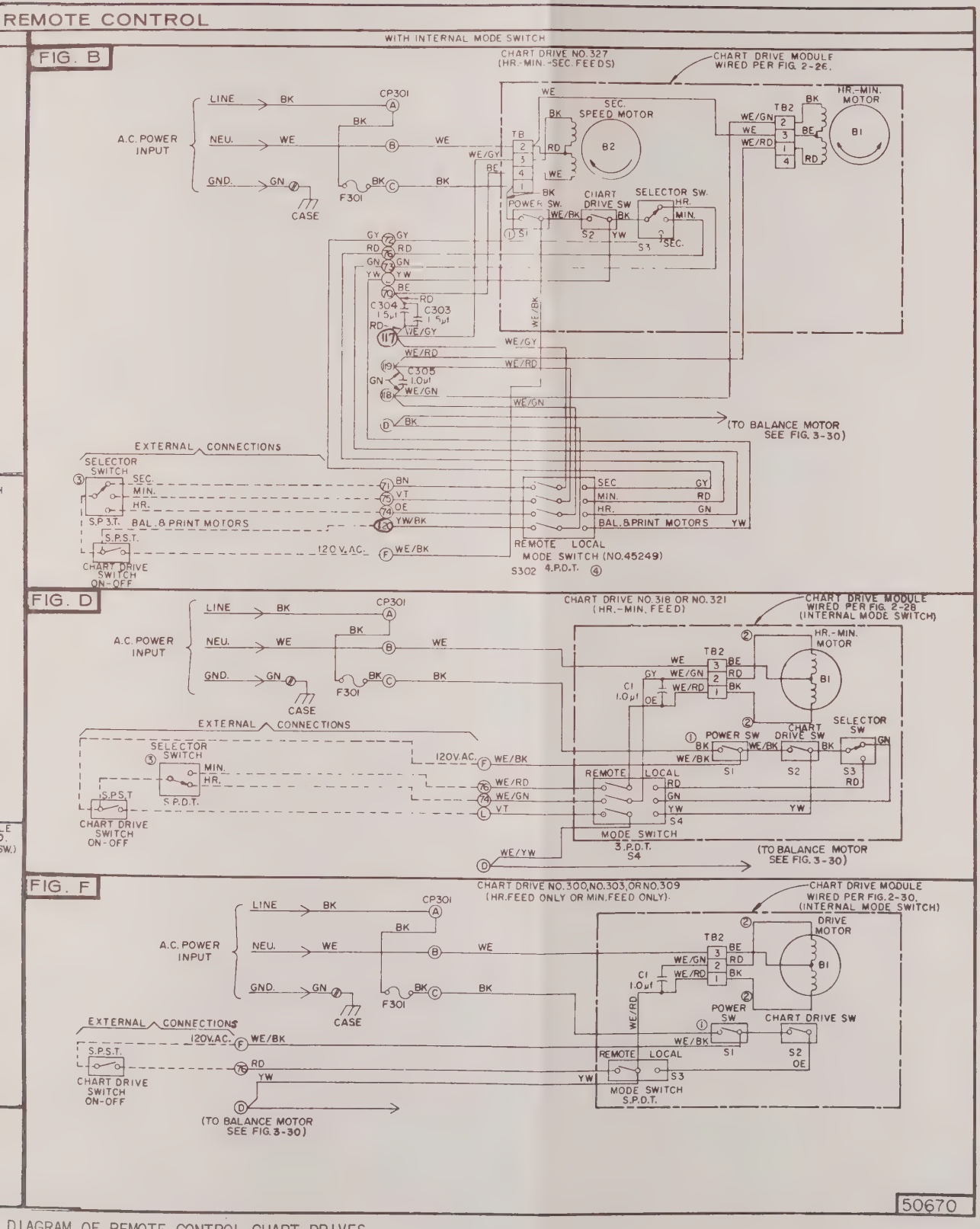


DIAGRAM OF REMOTE CONTROL CHART DRIVES.

PART 3
MEASURING SYSTEM

SECTION I DESCRIPTION

GENERAL DESCRIPTION

This part of the instruction manual pertains to the electro-mechanical servo system and the printing/input selection system employed in the basic Model E1124E Strip Chart Multipoint Recorder.

This precision instrument is designed for industrial, laboratory, and general field applications. Its provisions for accepting multiple inputs, a measuring accuracy of 0.25%, a relatively high input impedance, and interference-free operation make it one of the most versatile and reliable instruments in the field of data acquisition. The recorder can continuously measure, indicate, and record the analog signal from any sensing element which produces an equivalent DC signal within the measurement range of the instrument.

The Model E1124E Multipoint is essentially a potentiometric measuring and recording instrument capable of making a printed record of up to 24 inputs. Each input signal is sequentially selected and applied to the measuring circuit by a motor-driven switching system. The printing system records the measured variables in a standard presentation form of a dot and a number--the dot representing the actual value of the measured variable and the number indicating the selected point (station). Although the basic design is for 24 points (stations), a fewer number-of-points can be accommodated. Point (Station) Change Conversion Kits are available for 2, 3, 4, 6, 8, 10, 12, 16, 18, 20, and 24 points. Complete information concerning the procedures for changing the number-of-points is described in the Mechanical Maintenance Section (Section III) of PART 3.

TECHNICAL SPECIFICATIONS*

GENERAL

Power Requirements	120 Volts AC, +10%, 50-60Hz, 90VA.
Ambient Temperature Range	+59°F to +110°F.
Weight	75 Lb.
Warm-Up Time	30 Minutes.

MEASURING SYSTEM

Measurement Inputs (Actuations)	See Instrument DATA SHEET for Specified Actuation and Input Measurement Range.
DC Millivolts	Millivolt Range Card (for Zero Based,** Zero Elevated, or Zero Suppressed Measurement Ranges) . . . 1MV (Minimum Span) to 100MV (Maximum Span).

*See PART 2 of This Manual for Chart Drive Specifications.
**A Zero Based Millivolt-Actuated Range Card Having an Input Measurement Range Above 0-1MV Has Built-In Provision for Conversion to 0-1MV Input Measurement Range.

TECHNICAL SPECIFICATIONS (Cont')

MEASURING SYSTEM (CONT'D)

DC Volts	Voltage Divider Card Used in Conjunction with Millivolt Range Card (for Zero Based,** Zero Elevated, or Zero Suppressed Measurement Ranges) . . . 0.1V (Minimum Span) to 300V (Maximum Span).
DC Current	Current Shunt Card Used in Conjunction with Millivolt Range Card (for Zero Based,** Zero Elevated, or Zero Suppressed Measurement Ranges).
Thermocouple	Thermocouple Range Card; Compensation Available for ISA Thermocouple Types J, K, R, S, T, and Y.
Range Change Provision	Changing of Range Card (or Cards).
Maximum Source Impedance	10,000 Ohms.
Input Impedance:	
0-100MV Ranges or Below	50,000 Ohms (Minimum) Off-Balance Input Impedance.
Ranges Above 0-100MV	High Impedance Voltage Dividers.
Reference Voltage Supply	Zener Diode Regulation; Temperature Compensated.
Amplifier	Solid State; All Silicon Transistors.
Controls	Comp, Span, Zero, Gain, Damping, Filter Adjust, Threshold, and Bias Level.
Servo (Balance) Motor	Rotary, Permanently Lubricated.
Standard Response Speeds***	0.5, 1, 4, or 20 seconds for full 10" Span.
Feedback Potentiometer	Slidewire, 0.1% Linearity; Sealed and Shielded.
Accuracy	±0.25% of Span for any Potentiometric Range or ±3.5 Microvolts--Whichever is Greater.
Deadband	0.1% of Span.
Sensitivity	±0.05% of Span.
Stray Rejection:	
Transverse	Two Times Span.
Longitudinal 60-Cycle AC	1,000 Times Span or 120 Volts--Whichever is Greater.
Longitudinal DC	300 Volts.

PRINTING/INPUT SELECTION SYSTEM

Printing Head	Mechanical Type with Replaceable Print Wheel and Ink Wheel (or Pad).
Standard Type of Printing	Dot and Number.
Color of Printing:	
Standard Unicolor Printing	Purple.
Standard Multicolor Printing	Up to Six Colors--Red, Green, Blue, Black, Purple, and Brown.
Print Frequencies***	See Instrument DATA SHEET for print frequency supplied.

*See PART 2 of This Manual for Chart Drive Specifications.
**A Zero Based Millivolt-Actuated Range Card Having an Input Measurement Range Above 0-1MV Has Built-In Provision for Conversion to 0-1MV Input Measurement Range.
***Servo Motor Response Speed Must be Faster Than Print Frequency.

TECHNICAL SPECICATIONS (Cont'd)

PRINTING/INPUT SELECTION SYSTEM (CONT'D)

Standard Printing Sequence:	
2, 3, 4, 6, 8, 12, or 24-Point (-Station) Input	Number-of-Points (-Stations) are Repeated in Sequence.
10-Point Input	Points 1 Through 10, 5 and 6 Repeated, 1 Through 10 Repeated, 5 and 6 Repeated.
16-Point Input	Points 1 Through 16, 5 Through 12 Repeated.
18-Point Input	Points 1 Through 18, 7 Through 12 Repeated.
20-Point Input	Points 1 Through 20, 9 Through 12 Repeated.
Manual Point (Station) Advance	Provides Manual Selection of Desired Point (Station).
Number-of-Points (-Stations)	2, 3, 4, 6, 8, 10, 12, 16, 18, 20, or 24 Points. Number-of-Points can be Changed by Use of Point (Station) Change Conversion Kit.
STANDARD OPTIONS	See Instrument DATA SHEET for Specified Options. Information Regarding Optional Features is Contained in the APPENDIX, PART 6.
Programmed Printing**	Positioning of Slide Switches Preselects Points (Stations) to be Either Printed or Skipped. Point Skipping Performed at Least One-Sixth the Rate (or Faster) of the Print Frequency.
Dual-Range Recording:	
Manual Dual-Range Selection	Positioning of Manually-Operated Slide Switch Changes Recording of all Points (Stations) from One Range to the Other (Range A to Range B, or Vice Versa).
Automatic Dual-Range Selection	Positioning of Manually-Operated Slide Switches Preselects Points (Stations) to be Recorded on either One Range (Range A) or the Other (Range B).
Dual Print Frequency***.	Two-Position Slide Switch Enables a Two-Speed Print Frequency.
Retransmitting Potentiometer	Maximum of Two Available. Resistance of Either 100 or 1,000 Ohms.
Alarms:	
Non-Selective	Operate on all Points (Stations)--Maximum of Six Available.
Selective	Only Operate on Selected Points (Stations) --Maximum of twelve Available.
Event Pen	One Available for Right-Margin Operation on Chart. Operates at any Single Rating from 6-48V DC or 10-120V AC (50-60Hz).
Analog Pen	Attaches to Print Mechanism to Provide a Continuous Analog Record of One Point (Station)--Print Motor Turned Off.
Thermocouple Burnout	Servo Measurement System Drives Recorder to Either Zero (Downscale Failsafe) or Full Scale (Upscale Failsafe).

*See PART 2 of This Manual for Chart Drive Specifications.
**Not Available if Instrument is Optionally Equipped With Dual Print Frequency.
***Not Available if Instrument is Optionally Equipped With Programmed Printing.

TECHNICAL SPECIFICATIONS* (Cont'd)

STANDARD OPTIONS (CONT'D)

AZAS	Adjustable Zero, Adjustable Span.
240-Volt Operation	Instrument Power Supplied from 240V:120V AC 50-60Hz, Step-Down Transformer; Externally Mounted.
Multirange Selector Switch; Includes PanelGRAPH (Flush) Accessory Module**	Permits Selection of Following Input Measurement Ranges: 0-1, 0-5, 0-10, 0-50, 0-100, and 0-500MV DC; 0-1, 0-5, 0-10, 0-50, and 0-100V DC.

*See PART 2 of This Manual for Chart Drive Specifications.
**A Multirange Recorder has a Measurement Accuracy of ±0.5% With a Maximum Source Impedance of 5,000 Ohms.

THEORY OF OPERATION

As shown in Figure 3.1, the multipoint recorder may be divided into two basic sections which deal with its principles of operation. These are as follows: (1) the servo measurement loop and (2) the printing/input selection system. A summary describing the operation of these two interrelated sections of the recorder follows. Thereafter, a more detailed description of the interrelated sections is given.

The selector switch assembly which is mechanically actuated through the motor-driven gearing arrangement of the printing/input selection system, couples the DC input signal from the multiple-input signal panel to the measuring circuit. Here the measurement (unknown) voltage is compared with an accurate known voltage as determined by the position of the wiper contact of the feedback potentiometer (slidewire). Any difference in voltage resulting from the comparison process is converted into an AC error voltage by the chopper and chopper transformer (T201). This AC error voltage is amplified in the amplifier and is impressed upon the control winding of the balancing motor. The resultant drive of the balancing motor (direction of rotation dependent upon phase of the error signal) is mechanically coupled to both the feedback potentiometer (slidewire) and the drive cable.

An electrical signal representing the position of the balancing motor is fed back from the potentiometer to the measuring circuit to rebalance any voltage difference between the known and measurement (unknown) voltages, thus establishing the null-balance point. A mechanical signal representing the position of the balancing motor is produced by the horizontal displacement of the drive cable to which the printhead of the printing system is attached. With the servo system in a null-balance condition and with the printhead horizontally displaced to a value equivalent to the input measurement value as indicated by the pointer position on the scale, the concluding operation is the print-out of the measured value on the recording chart.

Printing on the chart is controlled by the printing mechanism through a cam which allows a free-fall vertical displacement of the printhead. The print-out is in the form of a dot and a number --the dot representing the actual value of the measured variable and the number indicating the point (station) being measured.

The operation of the two interrelated sections of the recorder is likewise repeated for the measuring and recording process of each point (station) selected as the selector switch is automatically advanced to succeeding positions by the point (station) advancing mechanism.

SERVO MEASUREMENT LOOP

The servo measurement loop is comprised of the components that are involved in the selection and measurement of the input signal. These components include

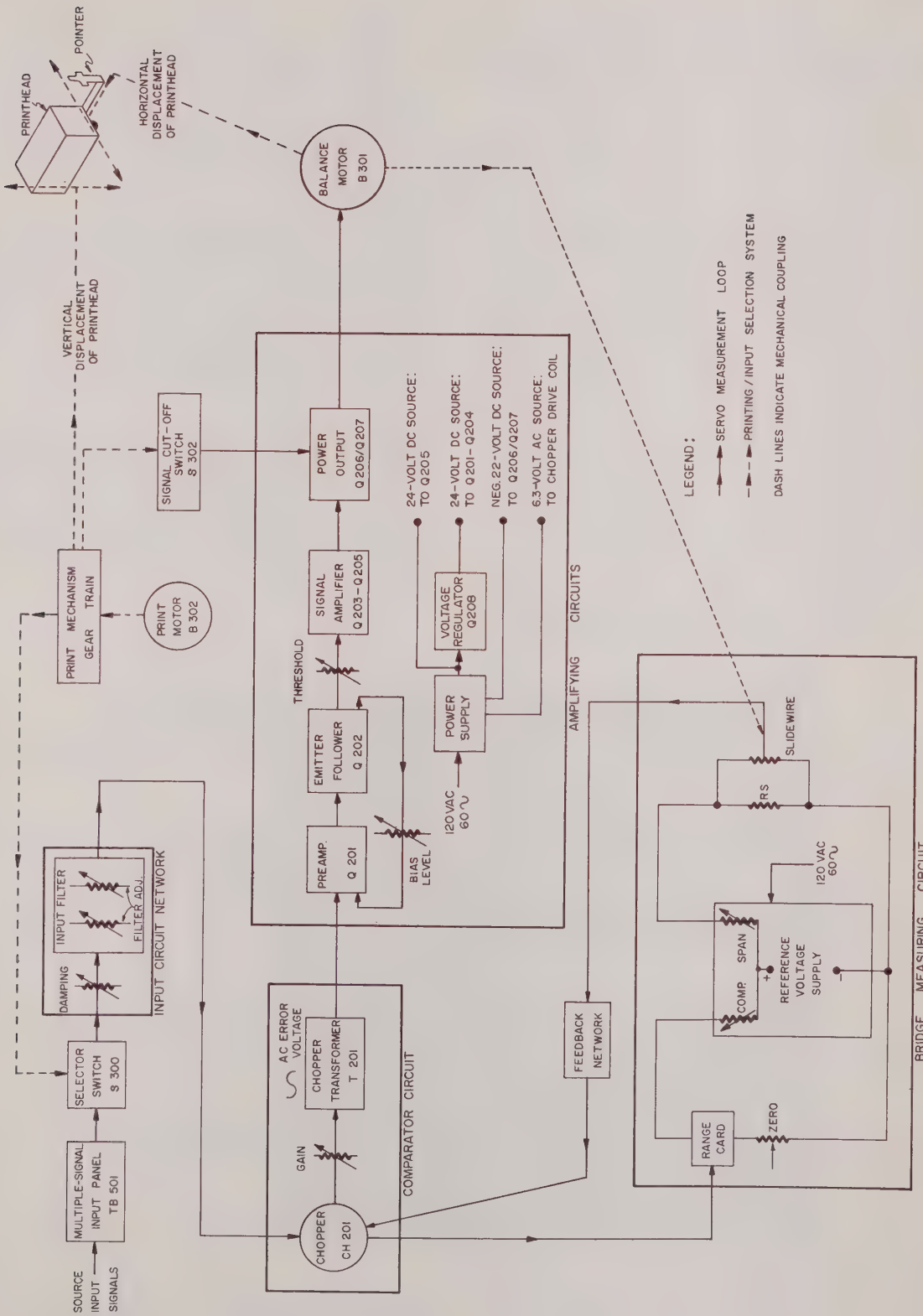


FIGURE 3.1. FUNCTIONAL BLOCK DIAGRAM OF MULTIPOINT RECORDER.

THE MULTIPLE-SIGNAL INPUT PANEL, THE SELECTOR SWITCH ASSEMBLY, THE MEASURING CIRCUIT, THE AMPLIFIER, AND THE BALANCING (SERVO) MOTOR.

THE SERVO MEASUREMENT LOOP OPERATES ON THE NULL-BALANCE PRINCIPLE OF MEASUREMENT.

THE INPUT SIGNAL TO BE MEASURED IS FED FROM THE INPUT PANEL TO THE MEASURING CIRCUIT BY MEANS OF THE SELECTOR SWITCH ASSEMBLY. THE MEASURING CIRCUIT COMPARES THE MEASUREMENT (UNKNOWN) VOLTAGE WITH AN ACCURATE KNOWN VOLTAGE AS DETERMINED BY THE POSITION OF THE WIPER CONTACT OF THE FEEDBACK POTENTIOMETER (SLIDEWIRE). ANY UNBALANCE IN THE COMPARISON PROCESS IS CONVERTED INTO AN AC ERROR SIGNAL AND IS AMPLIFIED BY THE AMPLIFIER. THE AC OUTPUT OF THE AMPLIFIER ENERGIZES THE BALANCING MOTOR WHICH IN TURN DRIVES THE FEEDBACK POTENTIOMETER (SLIDEWIRE) UNTIL THE FEEDBACK VOLTAGE BALANCES THE UNKNOWN VOLTAGE IN THE MEASURING CIRCUIT. WHEN BALANCE IS RESTORED, NO ERROR SIGNAL IS DEVELOPED TO THUS ESTABLISH THE NULL-BALANCE PRINCIPLE OF MEASUREMENT. THE POSITION TO WHICH THE BALANCING MOTOR DRIVES TO ACCOMPLISH THE NULL-BALANCE CONDITION IS MECHANICALLY COUPLED TO THE PRINTHEAD AND IS DISPLAYED ON THE SCALE (BY POINTER) AND THE CHART (BY PRINTING) AS A DIRECT MEASUREMENT OF THE UNKNOWN VOLTAGE.

MULTIPLE-SIGNAL INPUT PANEL: THE MULTIPLE-SIGNAL INPUT PANEL (FIGURE 3.2) PROVIDES CONNECTIONS FOR 24 INDIVIDUAL SIGNAL SOURCES. THE PANEL UNIVERSALLY ACCEPTS INPUT ACTUATIONS FROM DC MILLIVOLT, DC VOLT, DC CURRENT, THERMOCOUPLE, OR DC RESISTANCE (RTD; RESISTANCE TEMPERATURE DETECTOR) SIGNAL SOURCES.

NOTE: ALTHOUGH THE SAME INPUT PANEL MAY BE USED FOR THE CONNECTION INPUTS FROM DIFFERENT TYPES OF ACTUATION, IN SINGLE-RANGE RECORDERS IT IS NOT POSSIBLE TO INTERMIX INPUTS FROM DIFFERENT ACTUATIONS DUE TO THE SPECIFICS OF THE AMPLIFIER RANGE CARD AND OTHER RANGE-CHANGING REQUIREMENTS.

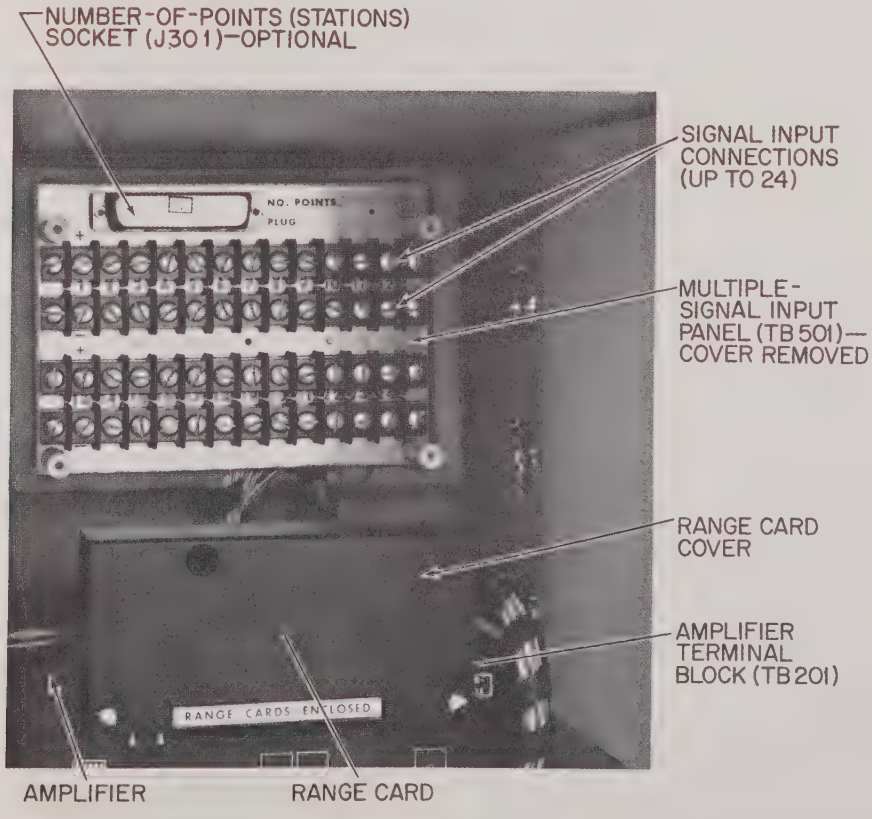


FIGURE 3.2. FRONT INTERNAL VIEW OF CASE SHOWING SIGNAL INPUT PANEL.

To enable precise measurement of thermocouple signals, the input terminals are housed in an insulated enclosure which maintains an even temperature gradient among all the terminals. A temperature sensitive compensating resistor (one resistor used for single-range multipoint; two resistors used for dual-range multipoint) mounts in the aluminum heat sink on the panel and develops a correcting voltage which cancels or offsets the thermocouple voltages developed at the input (cold junction) terminals.

Standoff and stud assemblies are used at each of the four mounting corners of the signal input panel (TB501) to completely insulate (float) the input panel from the instrument case. All input panel cable leads (including the leads from the temperature compensating resistor) which connect to the amplifier terminal block TB201 are shielded. The shield wire is connected to the input panel bottom cover (shield) and to terminal number 1 on TB201. These connections of the signal input circuitry are shown on the schematic in Figure 3.27 located in Electrical Maintenance Section (Section III) of PART 3. This grounding and shielding configuration of the input circuitry, coupled with the floating arrangement of the input panel and amplifier, completely floats the input and signal-conditioning circuits with respect to the instrument case or system ground (⏚).

Selector Switch Assembly (See Figures 3.3 and 3.4): The signal selector switch deck of the selector switch assembly sequentially connects the DC input signals from the multiple-input signal panel to the measuring circuit.

The 24-position selector switch assembly is driven by a pawl-and-ratchet arrangement so that the rotor contacts move ahead one point (station) every time the cam follower moves out of the notch in the gearbox output cam. The intermittent rotation of the selector switch shaft is also transmitted by gearing to the remainder of the print mechanism through the selector switch output pinion.

The basic multipoint recorder has a single 24-position signal switch deck. The switch deck is either shorting (make-before-break) or non-shorting (break-before-make) as ordered by the customer. The break-before-make (bbm) switch deck has 48 contacts in each circle instead of the 24 contacts which are used in the make-before-break (mbb) switch deck. However, every other contact of the bbm switch deck is inactive and is only used to smoothly guide the rotor to the next live contact.

An additional switch deck is used when the recorder is equipped with any one of the following optional features: programmed printing, automatic dual-range selection, automatic dual-range selection with programmed printing, and selective alarms. Therefore, by use of optional features, the selector switch assembly may be composed of up to three switch decks. Refer to the instrument DATA SHEET to determine optional features incorporated into a particular recorder. The part number of the selector switch assembly installed in a given instrument is also listed on the DATA SHEET.

Complete Measuring Circuit (Refer to Figure 3.5): The complete measuring circuit consists of the reference voltage supply, the range card, the ZERO control, the chopper and chopper transformer (comparator circuit), the slidewire (feedback potentiometer), and the input signal source.

Reference Voltage Supply

The reference voltage supply (Figure 3.4) provides the regulated DC voltage source for the measuring circuit. Reference voltage supply circuitry is shown in the Servo Measurement Loop Schematic (see Figure 3.28).

The reference supply incorporates two zener diodes (CR101 and CR102) to maintain stable voltage regulation; zener diode CR102 is a selected temperature-compensated unit.

The COMP control adjusts the value of DC reference voltage which is applied to the range card and ZERO control leg of the bridge-configurated, measuring circuit. As shown in Figure 3.5, the reference voltage supplied to this leg is directly connected to terminals 6 (positive) and 9 (negative) of the amplifier terminal block TB201. Varying the adjustment of the COMP control provides an adjustable reference output between the limits of approximately 4.8 to 6.8 volts as measured across terminals 6 and 9 of TB201. The COMP control must be precisely set in order to obtain the span limits of the various measuring ranges.

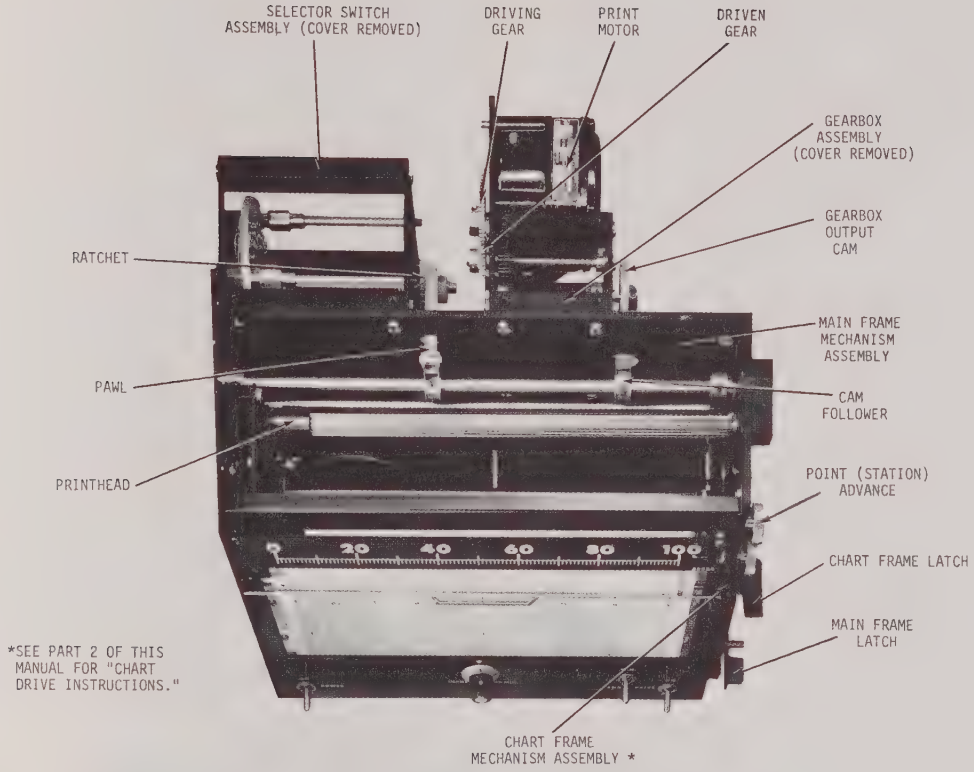


FIGURE 3.3. TOP VIEW OF SWING-OUT MECHANISMS.

THE SPAN CONTROL ADJUSTS THE VALUE OF DC REFERENCE VOLTAGE APPLIED TO THE SLIDEWIRE LEG OF THE BRIDGE-CONFIGURATED, MEASURING CIRCUIT. AS SHOWN IN FIGURE 3.5, THE REFERENCE VOLTAGE SUPPLIED TO THIS LEG (SUPPLIED THROUGH PRECISION RESISTORS R105 AND R107) IS DIRECTLY CONNECTED TO THE CW AND CCW TERMINALS OF THE SLIDEWIRE. VARYING THE ADJUSTMENT OF THE SPAN CONTROL PROVIDES AN ADJUSTABLE REFERENCE OUTPUT BETWEEN THE LIMITS OF APPROXIMATELY 2.2 TO 3.8 VOLTS AS MEASURED ACROSS SLIDEWIRE TERMINALS CW AND CCW. THE SPAN CONTROL SETTING DETERMINES THE ACCURACY OF FULL-SPAN CALIBRATION. THE SPAN IS NORMALLY USED FOR THE CALIBRATION ADJUSTMENT AT THE UPPER END OF THE MEASUREMENT SPAN; HOWEVER, WHEN THE ZERO IS SUPPRESSED OR ELEVATED, ADJUSTMENT OF SPAN HAS SOME INTERACTION WITH THE ZERO CONTROL ADJUSTMENT.

WHEN THE SPAN AND COMP CONTROLS ARE SET FOR THEIR CORRECT OUTPUT VALUES, THE ZENER REGULATION MAINTAINS THESE VALUES WITHIN VERY CLOSE LIMITS WITHOUT ANY NEED FOR PERIODIC STANDARDIZATION.

ACCESS HOLES FOR THE ADJUSTMENT OF THE COMP AND SPAN CONTROLS ARE PROVIDED IN THE TOP OF THE REFERENCE SUPPLY COVER (SEE FIGURE 3.4).

RANGE CARD

THE RANGE CARD (FIGURE 3.2) IS AN IMPORTANT PART OF THE MEASURING CIRCUIT. IT CONSISTS OF PRECISION RESISTOR COMPONENTS, THE VALUES OF WHICH DETERMINE THE SPAN LIMITS OF THE MEASUREMENT RANGE. EACH RANGE CARD IS CLEARLY IDENTIFIED AS TO ITS TYPE OF ACTUATION AND THE MEASUREMENT RANGE.

WHEN THE INPUT MEASUREMENT SIGNAL IS DC VOLTS OR DC CURRENT, A VOLTAGE DIVIDER CARD OR CURRENT SHUNT CARD RESPECTIVELY IS USED IN CONJUNCTION WITH ONE OF THE MILLIVOLT-ACTUATED RANGE CARDS (EITHER ZERO BASED, ZERO SUPPRESSED, OR ZERO ELEVATED). THE VOLTAGE DIVIDER OR CURRENT SHUNT CARD CONVERTS THE INPUT SIGNAL TO AN EQUIVALENT MILLIVOLTAGE VALUE WITHIN

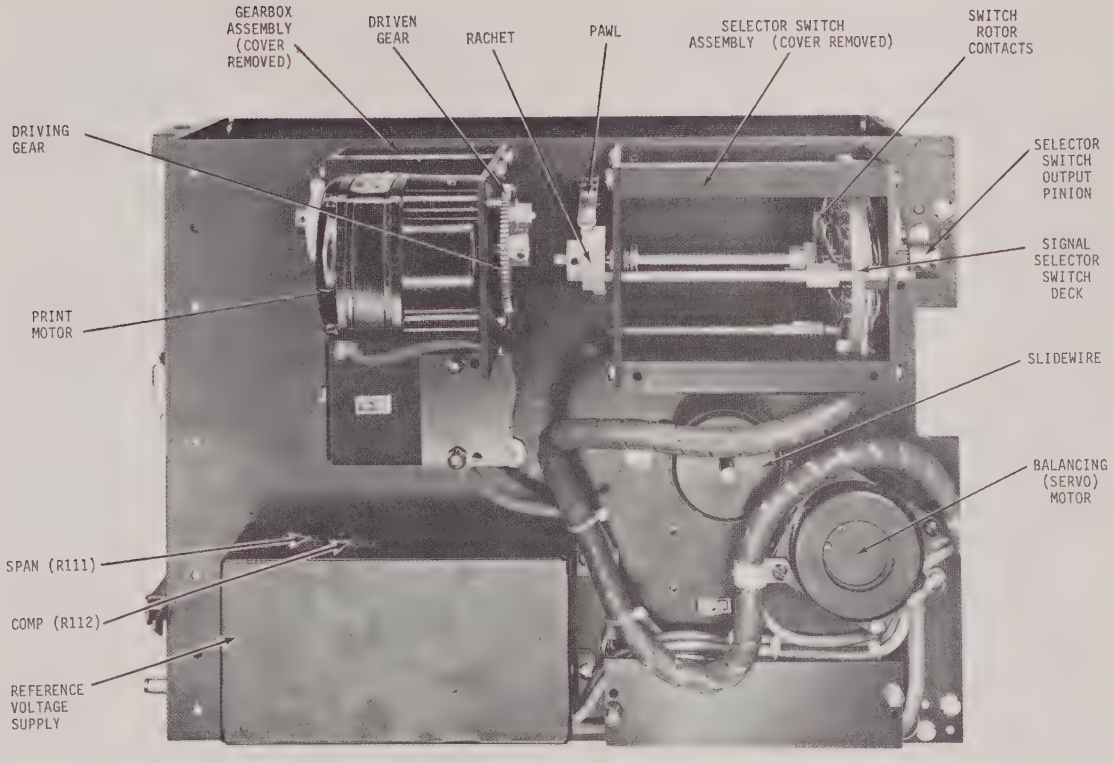


FIGURE 3.4. REAR VIEW OF MAIN SWING-OUT FRAME.

THE MEASUREMENT RANGE OF THE MILLIVOLT-ACTUATED MEASURING CIRCUIT. REFER TO RANGE CARD CIRCUIT SCHEMATICS SHOWN IN THE SERVO MEASUREMENT LOOP SCHEMATIC (SEE FIGURE 3.28).

THE RANGE CARD IS PROVIDED WITH SPADE LUGS FOR QUICK CONNECTION TO THE SCREW-TYPE TERMINALS ON THE AMPLIFIER TERMINAL BLOCK (TB201).

A CHANGE IN THE MEASUREMENT RANGE IS MADE BY INSTALLING A DIFFERENT RANGE CARD. FOR COMPLETE INFORMATION ON "RANGE CHANGING," REFER TO SECTION III (MAINTENANCE) OF PART 3.

ZERO CONTROL

THE ZERO CONTROL IS LOCATED ON THE AMPLIFIER AND IS ELECTRICALLY CONNECTED INTO THE MEASURING CIRCUIT WHEN THE RANGE CARD IS INSTALLED. THIS CONTROL, IN CONJUNCTION WITH THE RANGE CARD COMPONENTS, PROVIDES MEASURING CIRCUIT ADJUSTMENTS TO THEREBY ESTABLISH MEASUREMENT RANGES BEGINNING AT ZERO, BELOW ZERO (ZERO ELEVATION), OR ABOVE ZERO (ZERO SUPPRESSION). THE ZERO CONTROL ADJUSTMENT IS ACCESSIBLE THROUGH A HOLE PROVIDED ON THE FRONT OF THE AMPLIFIER (FIGURE 3.22). THE ZERO CONTROL IS NORMALLY USED FOR THE CALIBRATION ADJUSTMENT AT THE LOWER END OF THE MEASUREMENT SPAN. WHEN THE ZERO IS SUPPRESSED OR ELEVATED, ADJUSTMENT OF ZERO HAS SOME INTERACTION WITH THE SPAN ADJUSTMENT.

CHOPPER AND CHOPPER TRANSFORMER (COMPARATOR CIRCUIT)

THE CHOPPER (CH201) AND CHOPPER TRANSFORMER ARE LOCATED ON THE AMPLIFIER AND ARE CONSIDERED AS THE FINAL COMPONENTS OF THE MEASURING CIRCUIT. ANY DC ERROR VOLTAGE DEVELOPED IN THE MEASURING CIRCUIT IS CONVERTED INTO AN EQUIVALENT AC ERROR SIGNAL BY THE CHOPPER AND CHOPPER TRANSFORMER.

THE CHOPPER IS ESSENTIALLY A SINGLE-POLE, DOUBLE-THROW SWITCH WHICH OPERATES AT A RATE OF 60 Hz TO CONVERT THE DC ERROR VOLTAGE INPUT INTO A 60 Hz AC ERROR SIGNAL. IT IS AN ELECTRO-MECHANICAL DEVICE WHICH CONSISTS OF A REED, A PERMANENT MAGNET, AND A DRIVE COIL. THE PERMANENT

MAGNET POLARIZES THE REED, AND THE ALTERNATING MAGNETIC FIELD CREATED BY THE DRIVE COIL CAUSES THE REED TO VIBRATE. THE ENERGIZING VOLTAGE FOR THE COIL IS SUPPLIED BY A SEPARATE WINDING ON THE POWER TRANSFORMER. THE REED IS VIBRATED AT THE FREQUENCY OF THE AC LINE VOLTAGE, AND ITS CONTACTS ALTERNATELY APPLY THE ERROR VOLTAGE ACROSS EACH HALF OF THE CHOPPER TRANSFORMER PRIMARY WINDING. THIS ACTION RESULTS IN AN AC VOLTAGE APPEARING ON THE SECONDARY WINDING OF THE CHOPPER TRANSFORMER. THIS VOLTAGE HAS THE SAME FREQUENCY AS THE LINE VOLTAGE AND A PHASE WHICH IS DEPENDENT ON THE POLARITY OF THE DC ERROR VOLTAGE SUPPLIED IN THE MEASURING CIRCUIT.

A GAIN CONTROL WHICH IS CONNECTED ACROSS THE PRIMARY WINDING OF THE CHOPPER TRANSFORMER ADJUSTS THE AMPLITUDE OR LEVEL OF THE AC ERROR SIGNAL. THE GAIN CONTROL IS LOCATED ON THE AMPLIFIER, AND ITS ADJUSTMENT IS PROVIDED THROUGH A HOLE ON THE FRONT OF THE AMPLIFIER (FIGURE 3.10).

SLIDEWIRE (FEEDBACK POTENTIOMETER)

THE SLIDEWIRE (FIGURE 3.4), WHICH IS MECHANICALLY POSITIONED BY THE BALANCING MOTOR, PROVIDES AN ACCURATE AND VARIABLE SOURCE OF FEEDBACK VOLTAGE. THIS VOLTAGE IS USED TO OPPOSE OR BALANCE THE MEASUREMENT (UNKNOWN) VOLTAGE IN THE COMPARATOR CIRCUIT, THUS ESTABLISHING A NULL-BALANCE OF THE MEASURING SYSTEM.

THE SLIDEWIRE IS A SEALED AND SHIELDED, ROTARY-TYPE PRECISION POTENTIOMETER. A PRECISION SHUNT RESISTOR, EXTERNALLY CONNECTED ACROSS THE CW AND CCW TERMINALS OF THE POTENTIOMETER, IS AN INTEGRAL PART OF THE CONTROL. THE POTENTIOMETER AND THE SHUNT RESISTOR PROVIDE AN EQUIVALENT SLIDEWIRE RESISTANCE OF 900 OHMS $\pm$0.1% WITH A LINEARITY OF $\pm$0.1%.

MEASURING CIRCUIT ANALYSIS OF MILLIVOLT-ACTUATED INPUTS

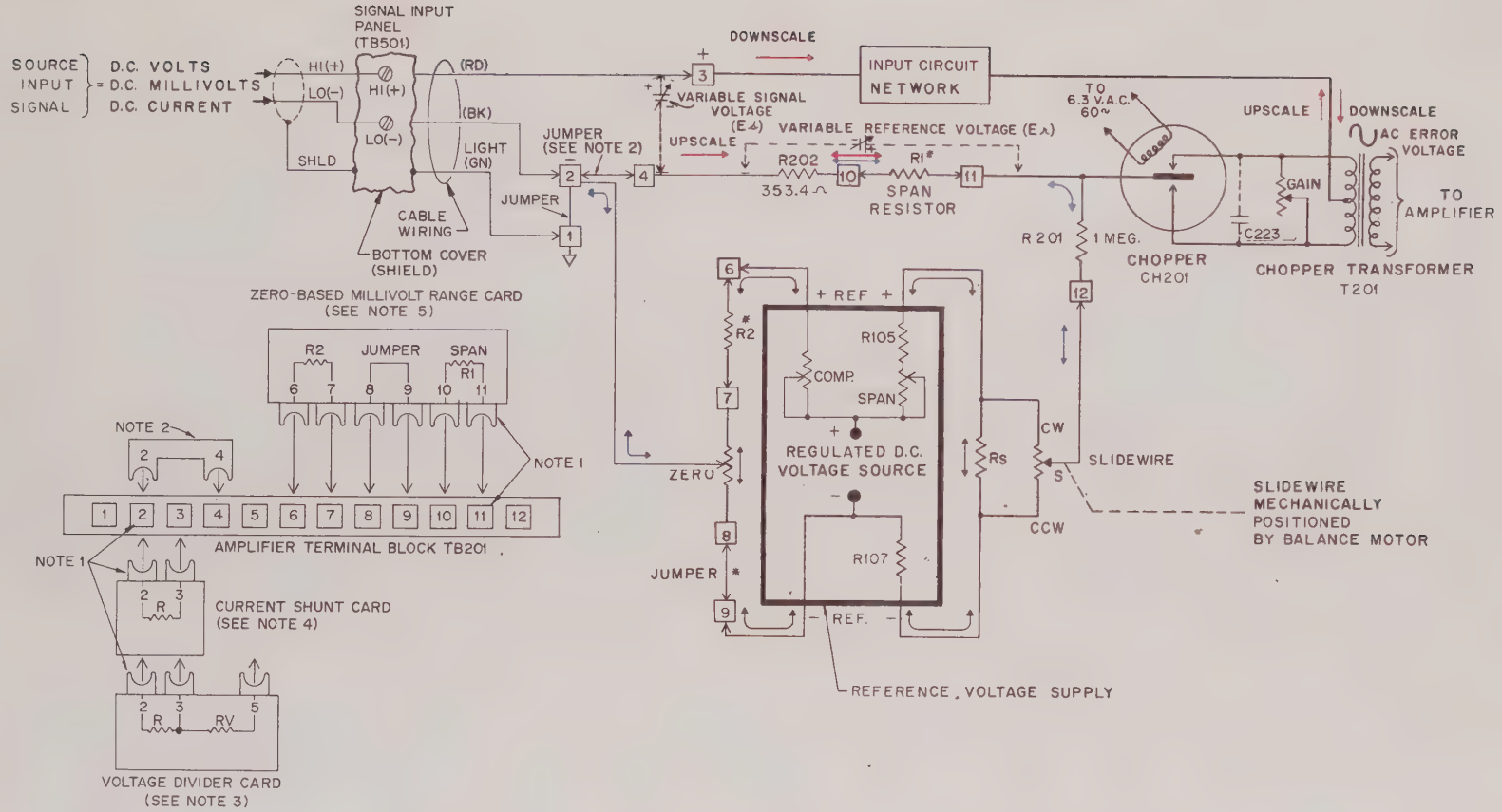
A TYPICAL MILLIVOLT-ACTUATED MEASURING CIRCUIT IN WHICH THE MEASUREMENT RANGE BEGINS AT ZERO MV IS SHOWN IN FIGURE 3.5. THE MEASURING CIRCUIT IS DIVIDED INTO THREE BASIC CIRCUIT PATHS: (1) ONE PATH IN WHICH FIXED REFERENCE CURRENTS FLOW, (2) ONE PATH IN WHICH VARIABLE REFERENCE CURRENTS FLOW, AND (3) ONE PATH IN WHICH ERROR CURRENTS FLOW.

(1) FIXED REFERENCE CURRENTS: FIXED REFERENCE CURRENTS ARE DEVELOPED IN THE BRIDGE-CIRCUIT CONFIGURATION CONSISTING OF THE RANGE CARD AND ZERO CONTROL IN ONE LEG OF THE BRIDGE, AND THE SLIDEWIRE IN THE OTHER LEG. THE REGULATED OUTPUT OF THE REFERENCE VOLTAGE SUPPLY IS FED THROUGH THE COMP CONTROL TO THE LEG OF THE BRIDGE WHICH CONSISTS OF THE RANGE CARD AND THE ZERO CONTROL. THIS SAME REGULATED OUTPUT IS ALSO APPLIED THROUGH THE SPAN CONTROL AND TWO PRECISION RESISTORS (R105 AND R107) TO THE OTHER LEG OF THE BRIDGE WHICH CONSISTS OF THE SLIDEWIRE. EACH LEG OF THE BRIDGE DRAWS ABOUT 2.6MA, THUS ESTABLISHING THE FIXED REFERENCE CURRENTS. THESE CURRENTS DEVELOP THE PROPER VOLTAGES FOR THE ELEVATION OR SUPPRESSION OF THE ZERO AND ALSO DEVELOP A VOLTAGE SOURCE ACROSS THE SLIDEWIRE.

(2) VARIABLE REFERENCE CURRENTS: THE VARIABLE REFERENCE CURRENTS FLOW BETWEEN THE WIPER CONTACT OF THE SLIDEWIRE AND THE WIPER CONTACT OF THE ZERO CONTROL. THIS CURRENT IS ZERO WHEN THE ZERO WIPER CONTACT AND THE SLIDEWIRE WIPER CONTACT ARE AT THE SAME POTENTIAL. RESISTORS R1, R202, AND R201 FORM A VOLTAGE DIVIDER NETWORK BETWEEN THE WIPER CONTACTS. RESISTORS R202 AND R1 ARE THE SPAN-DETERMINING RESISTORS OF THE MEASUREMENT RANGE. RESISTOR R1 IS LOCATED ON THE RANGE CARD, WHEREAS RESISTORS R202 AND R201 ARE LOCATED ON THE AMPLIFIER. THE SPAN RESISTOR (R1) ON THE RANGE CARD ALWAYS HAS ONE OF ITS TERMINALS CONNECTED TO TERMINAL 11 OF TB201.

BECAUSE OF THE VALUE (1 MEG.) OF VOLTAGE DIVIDING RESISTOR R201 AND THE RELATIVELY SMALL VALUES OF THE SPAN RESISTORS (R1, R202), ONLY A SMALL PORTION OF THE VOLTAGE (VARIABLE REFERENCE VOLTAGE, E_R) BETWEEN THE WIPER CONTACTS IS DEVELOPED ACROSS THE SPAN RESISTORS.

(3) ERROR CURRENTS: ERROR CURRENTS FLOW IN THE CIRCUIT COMPOSED OF THE INPUT SOURCE, THE SPAN RESISTORS (R1, R202), THE CHOPPER, AND THE INPUT CIRCUIT NETWORK. THE VARIABLE SIGNAL VOLTAGE (E_S) IS ALWAYS OPPOSED BY THE VARIABLE REFERENCE VOLTAGE (E_R) DEVELOPED ACROSS THE SPAN RESISTORS (R1, R202). THE SPAN RESISTORS ARE COMMON-CONNECTED TO BOTH THE VARIABLE REFERENCE-CURRENT CIRCUIT PATH AND THE ERROR-CURRENT CIRCUIT PATH.



LEGEND

- INDICATES SPADE LUG CONNECTIONS TO NUMBERED TERMINALS ON AMPLIFIER TERMINAL BLOCK TB201.
- * RANGE CARD COMPONENT
- ERROR CURRENTS
- VARIABLE REFERENCE CURRENTS
- FIXED REFERENCE CURRENTS
- FLOATING SIGNAL GROUND

NOTES

NOTE 1 NUMBERED SPADE LUG TERMINALS ON RANGE CARDS CONNECT TO CORRESPONDING NUMBERED TERMINALS ON AMPLIFIER TERMINAL BLOCK TB201.

NOTE 2 JUMPER IS ONLY USED WITH A ZERO-MILLIVOLT-BASE RANGE CARD. JUMPER IS REMOVED WHEN ANY OTHER RANGE IS USED.

NOTE 3 USED IN CONJUNCTION WITH MILLIVOLT RANGE CARD FOR MEASUREMENT RANGES ABOVE 100 MV.

NOTE 4 USED IN CONJUNCTION WITH MILLIVOLT RANGE CARD FOR MEASUREMENT RANGES OF 100 MV AND BELOW.

NOTE 5 USED FOR MEASUREMENT RANGES OF 100 MV AND BELOW.

FIGURE 3.5. TYPICAL MILLIVOLT-ACTUATED MEASURING CIRCUIT SCHEMATIC (MEASUREMENT RANGE BEGINNING AT ZERO MV).

When E_S and E_R are equal, the two voltages cancel each other out so that no current flows through the chopper. Hence, the system is in a null-balance condition.

When E_S rises above the momentary value of E_R, E_S is able to drive upscale current through the chopper. The balance motor drives the slidewire in a direction so that E_R again balances E_S, at which point current through the chopper stops.

When E_S falls below the momentary value of E_R, E_R acts as a voltage source and drives downscale current through the chopper to cause a reversal of current through the signal source. The balance motor drives downscale until E_R is reduced so that it is again in balance with E_S.

As shown in Figure 3.5, error currents also flow through the input circuit network. This network consists of the DAMPING control and two filter controls. The DAMPING control is connected in series with the measurement signal and is adjusted to prevent excessive overshoot in the servo measurement loop. The filter controls are used to adjust a "Twin T" configurated input filter circuit for optimum suppression of power frequency interference signals.

The DAMPING control adjustment is accessible through a hole provided on the front of the amplifier (Figure 3.10).

Zero Elevated and Zero Suppressed Millivolt-Actuated Measurement Ranges

Millivolt measurement ranges in which the zero is elevated or suppressed utilize millivolt range cards which are of different circuit configurations than the zero-based, millivolt range card. The zero-suppressed or zero-elevated range card enables a ZERO control adjustment which will conform to the beginning or low-end value of the measurement range. For example, a measurement range of 10 to 50 MV would require the use of a zero-suppressed, millivolt range card; and a measurement range of -5 to +5MV would require the use of a zero-elevated, millivolt range card.

Although the zero-suppressed or zero-elevated millivolt range card is of a different circuit configuration than the zero-based millivolt range card, the same principles involved in the measuring circuit analysis--as related to Figure 3.5--may also be applied. In zero-suppressed or zero-elevated millivolt measurement ranges, resistor R202 and terminal 10 of the amplifier terminal block (TB201) are not actively connected into the measuring circuit.

The circuit schematics of the zero-suppressed and zero-elevated millivolt range cards are shown in the Servo Measurement Loop Schematic (see Figure 3.28).

DC Voltage-Actuated Measurement Ranges (above 100MV)

For DC-volt input signals above 100MV, a voltage divider card is used in conjunction with one of the millivolt-actuated range cards--either zero based, zero elevated, or zero suppressed. The divider card attenuates the measurement signal to a millivoltage value within the measurement range of the millivolt-actuated measuring circuit. The card is connected across terminals 2, 3, and 5 of TB201. The entire DC voltage input signal from the input source is impressed across terminals 2 and 5 of TB201. The millivoltage divided across terminals 2 and 3 of TB201 results as the measurement signal. This signal voltage is then fed into one of the conventional millivolt-actuated measuring circuits--either zero based, zero elevated, or zero suppressed.

The schematic of the voltage divider card is shown in Figure 3.5 and in the Servo Measurement Loop Schematic (see Figure 3.28).

DC Current-Actuated Measurement Ranges

For DC-current input signals, a current shunt card is used in conjunction with one of the millivolt-actuated range cards--either zero based, zero elevated, or zero suppressed. The current shunt card is connected across terminals 2 and 3 of TB201. The current signal from the input source develops a millivoltage drop across the shunt resistor. This millivoltage drop becomes the measurement signal and is fed into one of the conventional millivolt-actuated measuring circuits--either zero based, zero elevated, or zero suppressed.

The schematic of the current shunt card is shown in Figure 3.5 and in the Servo Measurement Loop Schematic (see Figure 3.28).

Measuring Circuit Analysis of Thermocouple-Actuated Inputs: A typical thermocouple-actuated measuring circuit is shown in Figure 3.6. A thermocouple-actuated measuring circuit is essentially the same as a millivolt-actuated measuring circuit since the input signal from the thermocouple is nothing more than an equivalent emf signal which is developed at the temperature measuring junction of the thermocouple.

The millivolt-actuated measuring circuit theory (see topic heading "Measuring Circuit Analysis of Millivolt-Actuated Inputs") dealing with fixed reference currents, variable reference currents, and error currents is also applicable to the thermocouple-actuated measuring circuit except for the following differences which become apparent when comparing Figures 3.5 and 3.6.

(1) Fixed reference currents--No differences; same theory as millivolt-actuated measuring circuit illustrated in Figure 3.5.

(2) Variable reference currents--Same Theory as millivolt-actuated measuring circuit shown in Figure 3.5 except: (a) R1 and R201 form the voltage divider network between the wiper contacts of the ZERO control and slidewire, (b) R1 is the span-determining resistor of the measurement range, (c) R202 and terminal 10 of the amplifier terminal block (TB201) are not actively connected into the measuring circuit.

(3) Error currents--Same theory as millivolt-actuated measuring circuit shown in Figure 3.5 except: (a) R1 is the only span resistor, (b) R202 and terminal 10 of the amplifier terminal block (TB201) are not actively connected into the measuring circuit.

In addition to the measuring circuit theory differences listed above, a temperature measuring instrument also requires the use of additional components in the measuring circuit to establish the automatic reference junction (cold junction) compensation.

Automatic Reference Junction Compensation

When the leads of the sensing thermocouple are connected to the signal input terminals on the input panel (TB501), the dissimilar metals--where the thermocouple lead wires change to copper wires--create what is termed a reference or cold junction. Thus, the input terminals (cold junction) actually become another thermocouple which develops an emf signal in direct opposition to the emf signal developed by the measuring (hot) junction thermocouple. As long as this opposing emf signal from the input terminals (reference junction) is not cancelled or otherwise compensated, an accurate measurement of the sensing (or hot junction) thermocouple cannot be obtained.

The correcting or compensating circuitry necessary to counteract the thermocouple voltage developed at the reference or cold junction is produced by: (1) a network of compensating resistors which are an integral part of the thermocouple range card, and (2) a separate temperature compensating resistor, R_C, which mounts in the aluminum heat sink on the input panel. The network of compensating resistors on the range card is combined with the network of precision resistors that elevate or suppress the zero. However, the generating of the reference junction compensating voltages and the generating of

THE ZERO VOLTAGES ARE COMPLETELY DISTINCT FUNCTIONS.

AS SHOWN IN FIGURE 3.6, THE CORRECTING OR COMPENSATING CIRCUITRY IS ESTABLISHED IN THE LEG OF THE MEASURING BRIDGE WHICH CONSISTS OF THE THERMOCOUPLE RANGE CARD AND THE ZERO CONTROL. THE TEMPERATURE COMPENSATING RESISTOR R_C IS CONNECTED INTO THIS LEG OF THE MEASURING CIRCUIT AT TERMINALS 5 AND 8 OF TB201.

RESISTOR R_C (140Ω @ 90°F) IS MADE OF COPPER AND IS TEMPERATURE SENSITIVE--INCREASE IN TEMPERATURE INCREASES THE RESISTANCE; DECREASE IN TEMPERATURE DECREASES THE RESISTANCE (APPROXIMATE RESISTANCE CHANGE = .3Ω/°F.). THE RESISTOR IS PHYSICALLY MOUNTED IN THE ALUMINUM TERMINAL PANEL SO THAT IT CAN SENSE THE REFERENCE (COLD) JUNCTION TEMPERATURE OF THE INPUT TERMINALS.

WITHOUT COMPENSATION, THE MEASURED VALUE OF THE SENSING (HOT) JUNCTION THERMOCOUPLE WOULD READ LOW BY AN AMOUNT EQUAL TO THE VALUE OF THERMOCOUPLE VOLTAGE DEVELOPED ACROSS THE INPUT TERMINALS OF TB501 (REFERENCE JUNCTION). WITH COMPENSATION, HOWEVER, AN INCREASE OR DECREASE IN THE REFERENCE JUNCTION TEMPERATURE CAUSES A CORRESPONDING INCREASE OR DECREASE IN THE RESISTANCE OF R_C. THE RESISTANCE CHANGE OF R_C ACTS IN CONJUNCTION WITH THE COMPENSATING NETWORK OF RESISTORS ON THE RANGE CARD TO PROVIDE A COMPENSATING (CORRECTING) VOLTAGE ACROSS TERMINALS 2 AND 4 OF TB201. THIS COMPENSATING VOLTAGE IS OF EQUAL VALUE AND OF OPPOSITE POLARITY WITH RESPECT TO THE THERMOCOUPLE VOLTAGE DEVELOPED AT THE REFERENCE JUNCTION. THE COMPENSATING VOLTAGE IS FED THROUGH THE CHOPPER AND CANCELS OUT THE THERMOCOUPLE VOLTAGE DEVELOPED AT THE REFERENCE JUNCTION. CONSEQUENTLY, ONLY THE TRUE EMF VALUE OF THE MEASURING (HOT) JUNCTION REMAINS AS THE EFFECTIVE VOLTAGE TO BE MEASURED.

THE COMPENSATING NETWORK OF RESISTORS USED ON A THERMOCOUPLE RANGE CARD IS APPLICABLE TO ONLY ONE SPECIFIC MEASURING RANGE OF A PARTICULAR THERMOCOUPLE TYPE. THE AUTOMATIC PORTION (SEPARATE RESISTOR R_C ON INPUT PANEL) OF THE TEMPERATURE COMPENSATING NETWORK, HOWEVER, MAY BE USED WITH ANY THERMOCOUPLE RANGE CARD REGARDLESS OF THERMOCOUPLE TYPE USED. THE COMPENSATING CIRCUITRY FOR ALL THERMOCOUPLE TYPES AND MEASURING RANGES IS DESIGNED FOR A REFERENCE JUNCTION TEMPERATURE OF 90°F.

THERMOCOUPLE BURNOUT (OPTIONAL)

THERMOCOUPLE BURNOUT IS AN OPTIONAL FEATURE THAT MAY BE ADDED TO THE MEASURING CIRCUIT OF THE RECORDER. ITS FUNCTION ACTS AS A DETECTION SYSTEM TO GIVE QUICK WARNING TO THE OPERATOR IN CASE AN OPEN OR FAILURE SHOULD DEVELOP IN THE THERMOCOUPLE INPUT CIRCUIT CONNECTED TO THE RECORDER. THIS WARNING IS INDICATED BY A CONSTANT RECORDED VALUE AT EITHER FULL UPSCALE OR FULL DOWNSCALE, DEPENDING UPON THE DETECTOR CIRCUITRY USED.

AS SHOWN IN FIGURE 3.6, THE BURNOUT DETECTION CIRCUITRY CONSISTS OF A 22-MEGOHM RESISTOR WHICH MAY BE CONNECTED IN EITHER ONE OF TWO WAYS. IF THE RESISTOR IS CONNECTED AS SHOWN FOR R104, A POSITIVE VOLTAGE IS TAPPED OFF THE REFERENCE VOLTAGE SUPPLY AND IS FED THROUGH R104 TO TERMINAL 3 OF TB201. IF THE THERMOCOUPLE SHOULD OPEN OR OTHERWISE FAIL, SERVO MEASURING ACTION CAUSES A FULL UPSCALE INDICATION OF THE RECORDED VALUE. IF THE 22-MEGOHM RESISTOR IS CONNECTED AS SHOWN FOR R106, A NEGATIVE VOLTAGE IS TAPPED OFF THE REFERENCE VOLTAGE SUPPLY AND IS LIKEWISE APPLIED TO TERMINAL 3 OF TB201. WITH THIS ARRANGEMENT, HOWEVER, AN OPEN OR FAILURE IN THE THERMOCOUPLE INPUT CIRCUIT CAUSES A FULL DOWNSCALE INDICATION OF THE RECORDED VALUE.

THE THEORY INVOLVED IN THE BURNOUT DETECTING CIRCUITRY IS DESCRIBED AS FOLLOWS: AS LONG AS THE EXTERNAL CIRCUIT BETWEEN THE HI AND LO TERMINALS OF TB501 IS COMPLETED BY A NORMAL FUNCTIONING THERMOCOUPLE, THE MINUTE CURRENT DRAWN BY THE 22-MEGOHM RESISTOR TENDS TO COMPLETE ITS CIRCUIT TO THE OTHER SIDE OF THE REFERENCE SUPPLY THROUGH THE EXTERNAL SIGNAL SOURCE (BETWEEN HI AND LO TERMINALS OF TB501), AND THROUGH THE ZERO CONTROL AND RANGE CARD. THIS CIRCUIT PATH BYPASSES THE CHOPPER SO THAT THE VALUE OF THE INPUT SIGNAL IS MEASURED IN THE NORMAL MANNER. HOWEVER, IF THE SIGNAL SOURCE SHOULD OPEN, THE ONLY PATH FOR THE CURRENT DRAWN BY THE 22-MEGOHM RESISTOR IS

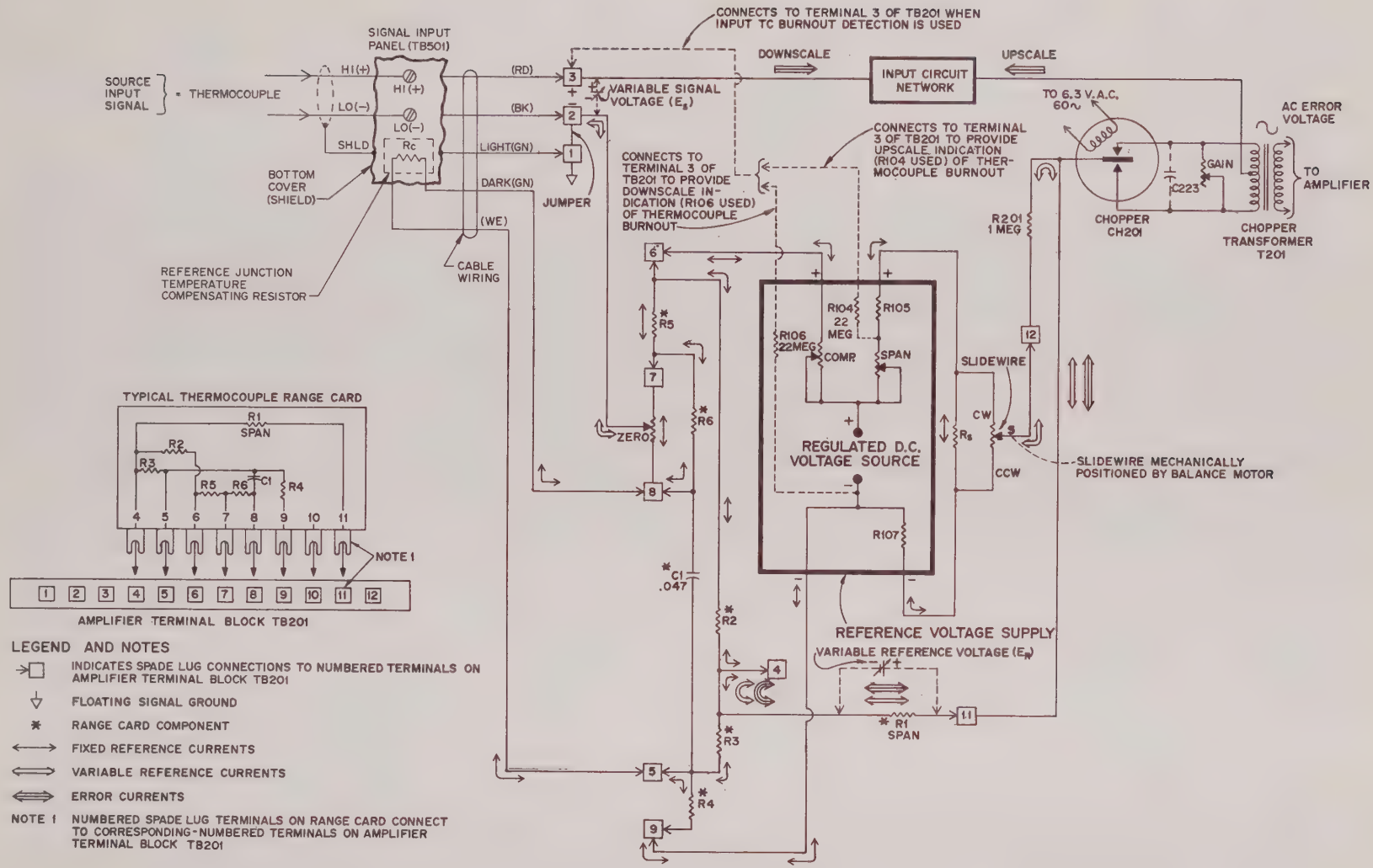


FIGURE 3.6. TYPICAL THERMOCOUPLE-ACTUATED MEASURING CIRCUIT SCHEMATIC.

THROUGH THE CHOPPER. AS A RESULT, SERVO MEASURING ACTION DRIVES THE RECORDER TO EITHER FULL UPSCALE (R104 USED) OR FULL DOWNSCALE (R106 USED).

NOTE: THE TYPE OF THERMOCOUPLE BURNOUT DETECTION (EITHER FULL UPSCALE OR FULL DOWNSCALE) AND THE PART NUMBER OF THE REFERENCE (ZENER) VOLTAGE SUPPLY FOR A PARTICULAR RECORDER ARE SPECIFIED ON THE INSTRUMENT DATA SHEET.

BURNOUT DETECTION IS ELIMINATED IF THE BURNOUT CONNECTION LEAD (RED WIRE) FROM THE REFERENCE VOLTAGE SUPPLY IS REMOVED FROM TERMINAL 3 OF TB201. THE ONLY EFFECT OF THE DETECTION CIRCUITRY ON THE MEASURING CIRCUIT IS THE INDUCEMENT OF A SMALL OFFSET IN THE MEASURING SPAN WHEN THIS LEAD IS CONNECTED OR DISCONNECTED. HOWEVER, ONCE THE LEAD IS LEFT EITHER CONNECTED OR DISCONNECTED AND THE OFFSET ERROR CORRECTED WITH THE ZERO CONTROL, THERE IS NO FURTHER EFFECT ON INSTRUMENT CALIBRATION. FOR INSTRUMENT CALIBRATION, REFER TO TOPIC HEADING "RECORDER CALIBRATION" IN SECTION III (MAINTENANCE) OF PART 3 IN THIS MANUAL.

IF A TEMPERATURE MEASURING INSTRUMENT EQUIPPED WITH THE THERMOCOUPLE BURNOUT FEATURE IS LATER FIELD-CONVERTED TO A DC VOLTAGE-ACTUATED INSTRUMENT (ABOVE 100MV MEASURING RANGE), IT WILL BE NECESSARY TO REMOVE THE BURNOUT CONNECTION (RED WIRE) FROM TERMINAL 3 OF TB201. RETENTION OF THE BURNOUT CONNECTION PRODUCES AN EXCESSIVE OFFSET ERROR WHICH IS BEYOND THE CORRECTION CAPABILITIES OF THE ZERO CONTROL. REFER TO SECTION III (MAINTENANCE) OF PART 3 FOR COMPLETE PROCEDURES ON "RANGE CHANGING."

NOTE: IN SOME APPLICATIONS, INPUT SIGNAL BURNOUT DETECTION (EITHER UPSCALE OR DOWNSCALE INDICATION) MAY ALSO BE USED FOR MILLIVOLT-ACTUATED INPUT SOURCES. CONSULT FACTORY FOR FURTHER INFORMATION.

AMPLIFIER: AS SHOWN IN FIGURE 3.1, ANY DIFFERENCE BETWEEN THE MEASUREMENT SIGNAL AND FEEDBACK SIGNAL IS CONVERTED INTO AN AC ERROR SIGNAL IN THE COMPARATOR CIRCUIT. THIS EXTREMELY LOW-LEVEL AC ERROR SIGNAL IS THEN COUPLED TO THE TRANSISTORIZED CIRCUIT STAGES OF THE AMPLIFIER. THE AMPLIFIER (FIGURE 3.2) CONSISTS OF FIVE VOLTAGE AMPLIFICATION STAGES AND ONE POWER OUTPUT STAGE. FOR SCHEMATIC PRESENTATION OF AMPLIFIER CIRCUITRY, REFER TO THE SERVO MEASUREMENT LOOP SCHEMATIC (SEE FIGURE 3.28).

VOLTAGE AMPLIFICATION STAGES

THE VOLTAGE AMPLIFICATION STAGES CONSIST OF CIRCUITRY ASSOCIATED WITH NPN-TYPE TRANSISTORS Q201 THROUGH Q205. THE DC VOLTAGE SUPPLY FOR THESE STAGES IS FILTERED AND ALSO ZENER-REGULATED FOR INCREASED STABILITY. THE INPUT SIGNAL FROM THE COMPARATOR CIRCUIT IS TRANSFORMER-COUPLED TO THE PREAMPLIFIER STAGE OF Q201. THE OUTPUT OF Q201, IN TURN, IS DC-COUPLED TO THE EMITTER-FOLLOWER CONFIGURATION OF Q202.

THE THRESHOLD CONTROL AND BIAS LEVEL CONTROL ARE CONNECTED IN THE EMITTER CIRCUIT OF Q202. THE THRESHOLD CONTROL IS AN OPERATOR ADJUSTMENT WHICH GOVERNS THE SENSITIVITY OF THE AMPLIFIER, AND ITS ADJUSTMENT IS ACCESSIBLE THROUGH A HOLE ON THE FRONT OF THE AMPLIFIER (FIGURE 3.10). REFER TO "OPERATOR CONTROL ADJUSTMENT PROCEDURES" IN SECTION II (OPERATION) OF PART 3 IN THIS MANUAL. THE BIAS LEVEL CONTROL IS A SERVICE ADJUSTMENT WHICH SETS THE DC OPERATING BIAS VOLTAGE FOR THE PREAMPLIFIER STAGE OF Q201. THIS ADJUSTMENT IS PRESET AT THE FACTORY AND SHOULD NOT REQUIRE READJUSTMENT IN THE FIELD. REFER TO "ELECTRICAL SERVICE ADJUSTMENTS" IN SECTION III (MAINTENANCE) OF PART 3 IN THIS MANUAL.

THE OUTPUT OF THE EMITTER-FOLLOWER Q202 IS CAPACITIVELY COUPLED TO A THREE-STAGE SERIES OF DC-COUPLED VOLTAGE AMPLIFIERS CONSISTING OF Q203, Q204, AND Q205.

POWER OUTPUT STAGE

THE OUTPUT OF Q205 IS COUPLED THROUGH A DRIVER TRANSFORMER TO THE POWER OUTPUT STAGE CONSISTING OF NPN-TYPE TRANSISTORS Q206 AND Q207. THE DC VOLTAGE SUPPLY FOR THIS STAGE IS SUPPLIED FROM A SEPARATE WINDING ON THE POWER TRANSFORMER (T203). THE CENTER-TAPPED CONTROL WINDING OF THE BALANCING MOTOR IS CONSTANTLY EXCITED WITH UNFILTERED FULL-WAVE PULSES THROUGH BOTH Q206 AND Q207. WITH NO SIGNAL ON THE BASES OF POWER TRANSISTORS

Q206 AND Q207, THESE UNFILTERED PULSES CANCEL OUT SO THAT THE INTERACTION BETWEEN THE CONTROL WINDING AND THE LINE-EXCITED REFERENCE WINDING OF THE BALANCING MOTOR PRODUCES A NULL-DRIVE OR NULL-BALANCE CONDITION.

HOWEVER, IF A SIGNAL IS IMPRESSED ON THE BASES OF THE POWER TRANSISTORS, THE PULSES THROUGH ONE TRANSISTOR CHANGE SO THAT ONE PULSE IS REDUCED IN AMPLITUDE AND THE NEXT ONE INCREASED. THE SAME CHANGE TAKES PLACE IN THE OUTPUT OF THE OTHER TRANSISTOR, BUT 180 DEGREES OUT OF PHASE WITH THE FIRST TRANSISTOR. THE NET VOLTAGE ON THE CONTROL WINDING INTERACTS WITH THE LINE-EXCITED VOLTAGE ON THE REFERENCE WINDING TO PRODUCE THE TORQUE THAT DRIVES THE BALANCING MOTOR.

THE DIRECTION OF DRIVE IS DETERMINED BY THE PHASE RELATION (LEADING OR LAGGING) BETWEEN THE CONTROL VOLTAGE AND THE LINE EXCITATION. THE PHASE OF THE CONTROL VOLTAGE IS DETERMINED BY THE DIRECTION OF ERROR CURRENT THROUGH THE CHOPPER.

BALANCING (SERVO) MOTOR: THE BALANCING MOTOR (FIGURE 3.4) IS A SPECIAL TYPE OF TWO-PHASE INDUCTION MOTOR WITH A MAXIMUM ARMATURE SPEED OF 1200RPM. THIS BASIC ARMATURE SPEED MAY BE FURTHER LOWERED THROUGH SUITABLE GEARBOX REDUCTION TO PROVIDE VARIOUS FULL-SCALE RESPONSE SPEEDS. BECAUSE OF THE SPECIAL DESIGN, THE MOTOR DIFFERS FROM ORDINARY INDUCTION MOTORS IN THAT THE RPM IS HIGHLY VARIABLE IN ACCORDANCE WITH THE AMPLITUDE OF THE AC VOLTAGE ON THE CONTROL WINDING (ASSUMING A REASONABLY CONSTANT LOAD). THIS PERMITS SMOOTHER OPERATION WITH LOW SIGNAL INPUTS AND REDUCES HUNTING. THE CENTER-TAPPED CONTROL WINDING CONSTANTLY PASSES UNFILTERED FULL-WAVE PULSES WHICH CANCEL OUT AS LONG AS NO SIGNAL IS APPLIED TO THE POWER TRANSISTORS Q206 AND Q207. THE LINE EXCITATION PASSES THROUGH A PHASING CAPACITOR C301 WHICH CAUSES ABOUT 50 DEGREES LEADING PHASE. ALTHOUGH THE NORMAL VOLTAGE ON THE REFERENCE WINDING IS ALMOST EXACTLY EQUAL TO LINE VOLTAGE, THE MOTOR CANNOT OPERATE WITH LINE VOLTAGE APPLIED DIRECTLY TO THE REFERENCE WINDING.

THE BALANCING MOTOR IS LISTED BY PART NUMBER ON THE DATA SHEET AS ORIGINALLY INSTALLED AT THE FACTORY. IT WILL VARY FROM ONE INSTRUMENT TO ANOTHER DEPENDING ON THE RESPONSE SPEED. A BALANCING MOTOR GEARBOX (USED FOR RESPONSE SPEEDS ABOVE 1 SECOND) IS INCLUDED IN A GIVEN MOTOR PART NUMBER AND IS NOT LISTED OR OFFERED SEPARATELY.

THE FULL-SCALE RESPONSE SPEED OF A GIVEN RECORDER IS DETERMINED BY THE BALANCING MOTOR, THE PINION, AND THE BULLGEAR. IN ADDITION TO THE BALANCING MOTOR, THE LATTER TWO ITEMS ARE ALSO LISTED ON THE DATA SHEET. IF A CHANGE IN RESPONSE SPEED IS DESIRED, ONE OR MORE OF THE ABOVE COMPONENTS MUST BE REPLACED. THE PROCEDURE FOR CHANGING THE FULL-SCALE RESPONSE SPEED IS DESCRIBED IN SECTION III (MAINTENANCE) OF PART 3. IF A CHANGE IN RESPONSE SPEED IS MADE, IT IS ADVISABLE (FOR FUTURE REFERENCE) TO KEEP AN ACCURATE RECORD OF THE COMPONENTS WHICH WERE INVOLVED IN THE CHANGE.

PRINTING/INPUT SELECTION SYSTEM

THE PRINTING/INPUT SELECTION SYSTEM, AS SHOWN IN BLOCK-DIAGRAM FORM IN FIGURE 3.1, IS COMPRISED OF THE COMPONENTS WHICH MECHANICALLY CONTROL THE SELECTION AND PRINTING OF THE MEASUREMENT SIGNAL. THESE COMPONENTS INCLUDE THE PRINT MOTOR, THE PRINT-MECHANISM GEAR TRAIN, AND THE PRINTHEAD. THE PRINT-MECHANISM GEAR TRAIN CONSISTS OF (1) THE GEAR COUPLING BETWEEN THE PRINT MOTOR AND ITS GEARBOX, (2) THE GEARBOX ITSELF, AND (3) THE INTERVENING GEAR-TRAIN DRIVE BETWEEN THE GEARBOX OUTPUT CAM AND THE PRINTHEAD. A WORKING RELATIONSHIP OF ASSOCIATED PARTS OF THE PRINTING/INPUT SELECTION SYSTEM IS SHOWN IN FIGURE 3.6-1.

OPTIONAL FEATURES MAY ALSO BE INCORPORATED INTO THE INPUT SELECTION SYSTEM--SUCH AS PROGRAMMED PRINTING, AUTOMATIC DUAL-RANGE SELECTION, AUTOMATIC DUAL-RANGE SELECTION WITH PROGRAMMED PRINTING, AND SELECTIVE ALARMS. REFER TO THE INSTRUMENT DATA SHEET TO DETERMINE OPTIONAL FEATURES INCORPORATED INTO A PARTICULAR RECORDER. INFORMATION REGARDING OPTIONAL FEATURES IS CONTAINED IN THE APPENDIX, PART 6.

THE REPETITION RATE OR PRINT FREQUENCY AT WHICH THE MEASUREMENT SIGNALS ARE PRINTED OUT ON THE CHART IS DETERMINED BY THE FOLLOWING FOUR COMPONENTS AND/OR ASSEMBLIES (SEE FIGURE 3.3):

(1) PRINT MOTOR (INCLUDES INTEGRAL GEARBOX).

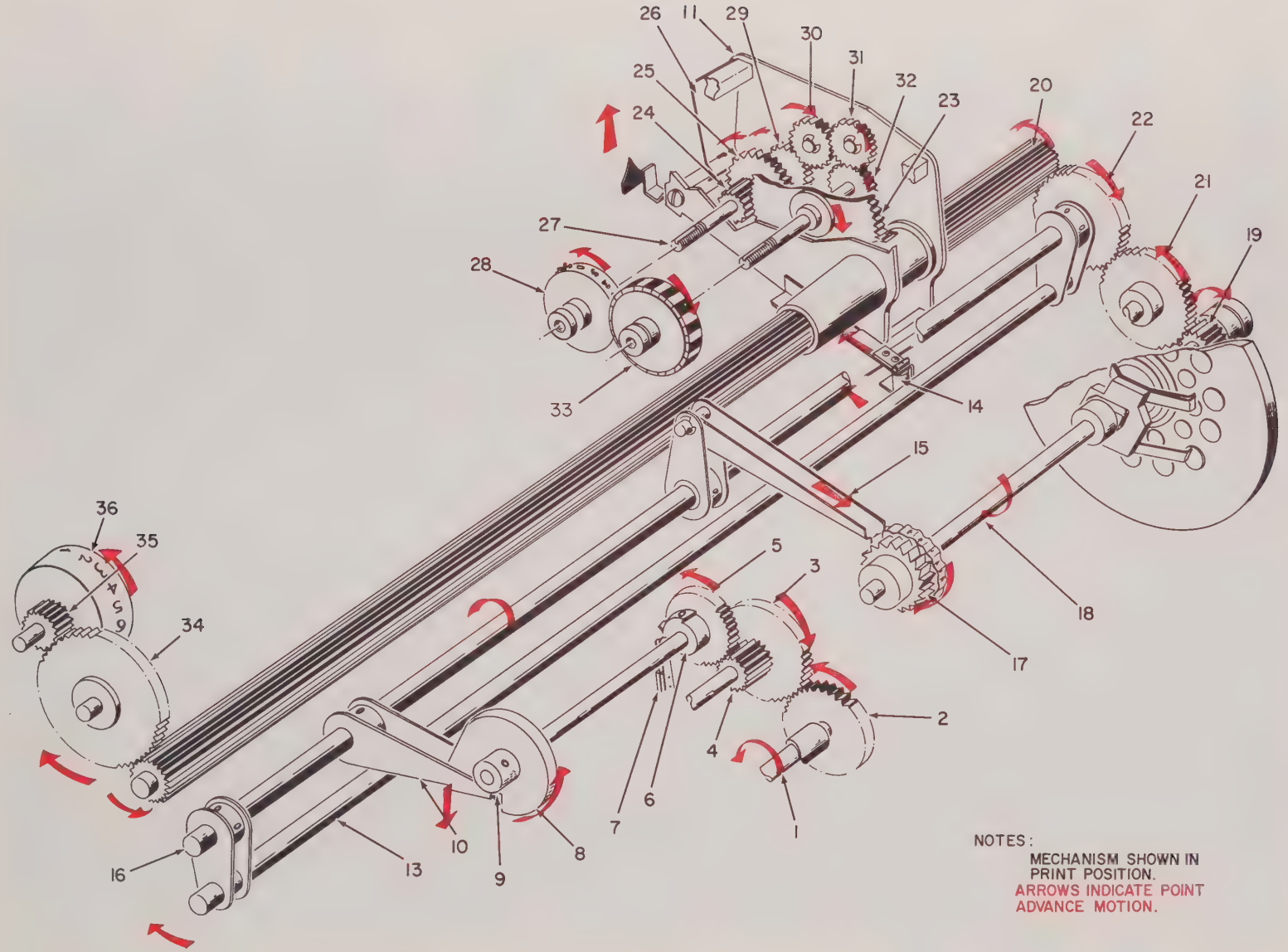


FIGURE 3.6-1. WORKING RELATIONSHIP OF ASSOCIATED PARTS OF PRINTING/INPUT SELECTION SYSTEM.

(2) Motor output (driving) intermediate gear.
(3) Gearbox input (driven) intermediate gear.
(4) Gearbox.

These items, as originally built into the recorder, are identified by part number on the instrument DATA SHEET and may be obtained by ordering these same part numbers. However, for other listing of parts associated with the gearbox used in the basic multipoint, refer to PART 4, ILLUSTRATED PARTS BREAKDOWN. For listing of parts associated with the gearbox used in a recorder optionally equipped with programmed printing or dual print frequency, refer to the information pertaining to the applicable option in the APPENDIX, PART 6.

The basic multipoint recorder (recorder not optionally equipped with programmed printing or the electrically-controlled, dual print frequency) uses a print mechanism gearbox that provides a selection of two different print frequencies for each set or combination of external intermediate-drive gears. This two-speed selection (in the speed ratio of 4:1) is accomplished by manually shifting a gear and pinion assembly that is located within the gearbox itself. The print frequencies (output speeds) of the mechanically speed-switched gearbox may be changed in the field by one or a combination of the following methods: (a) by changing the print motor, (b) by changing the external intermediate drive gears, and (c) by changing the position of the gear and pinion assembly within the gearbox. The procedure for changing the print frequency is described in SECTION III (Maintenance) of PART 3. If a change in print frequency is made, it is advisable (for future reference) to keep an accurate record of the components which were involved in the change.

Recorders optionally equipped with programmed printing or dual print frequency use overrunning clutches and additional gearing in the gearbox to perform the necessary mechanical operations. A description of these gearboxes is included in the information applicable to the specific option employed. Refer to the APPENDIX, PART 6.

Mechanical Analysis of Print Cycle (Refer to Figure 3.6-1):

NOTE: To observe the mechanical relationship of parts in the description which follows, swing out main frame assembly from case. Remove gearbox cover and selector switch assembly cover. Observe type of gearbox used. If the basic multipoint gearbox is used (no programmed printing option or dual print-frequency option), disengage one of the external, intermediate-drive gears (either driving or driven gear). Then manually turn the gearbox output cam in a counterclockwise direction to actuate the print-mechanism gear train. However, if overrunning clutches are used in the gearbox (programmed printing option or dual print-frequency option), no preliminary disengagement of gears becomes necessary--simply turn the gearbox output cam in a counterclockwise direction to actuate the print-mechanism gear train. Mechanical observations should be made on an instrument known to be in proper operating condition so that proper diagnosis can be performed if corrective maintenance becomes necessary.

The basic multipoint gearbox is used in reference to the mechanical description which follows. Gearboxes used on recorders optionally equipped with programmed printing or dual print frequency are different in mechanical appearance and operation, but primarily function the same to establish the drive power at the gearbox output cam (8). For principles of operation dealing with the gearboxes used in the programmed printing option or dual print-frequency option, refer to information applicable to the specific option used. See APPENDIX, PART 6.

The driving power for the printing/input selection system is derived from the print motor shaft (1). The print motor drive is coupled to the gearbox input through the two intermediate drive gears (2 and 3). The output of the gearbox is transferred through two coupling gears (4 and 5) and is terminated in the gearbox output cam (8). The gearbox output cam governs the mechanical operations of the print cycle and from this point on the mechanical analysis of the print cycle remains the same regardless of the gearbox used.

All the important events involved in printing and input selection take place while the cam follower (10) is in the cam notch (9) and a few degrees beyond this point. These events must be timed and synchronized, and reciprocating angular motions must have the correct starting positions and amplitudes.

PRINTING TAKES PLACE WHEN THE CAM FOLLOWER (10) DROPS INTO THE CAM NOTCH (9). THE MECHANICAL ACTIVITY UP TO THIS POINT IS DESCRIBED AS FOLLOWS:

(1) THREE OR FOUR DEGREES BEFORE THE CAM FOLLOWER (10) REACHES THE CAM NOTCH (9), THE SIGNAL CUT-OFF CAM (6) CLOSES THE SIGNAL CUT-OFF SWITCH (7). THIS ACTION SHORTS OUT THE SECONDARY WINDING OF THE DRIVER TRANSFORMER T202 ON THE AMPLIFIER, THUS DISABLING THE SERVO MEASUREMENT LOOP.

(2) AS THE CAM NOTCH (9) COMES ABREAST OF THE CAM FOLLOWER (10), THE WEIGHT OF THE PRINTHEAD (11) CAUSES THE CAM FOLLOWER TO DROP INTO THE NOTCH. AT THIS POINT, THE PRINTHEAD FREE-FALLS BY ITS OWN WEIGHT AND PRINTS ON THE CHART. AS THE PRINTHEAD STOPS IN ITS DOWNWARD TRAVEL, THE PRINTHEAD ACTUATING SHAFT (13) IS PULLED BACK AND CLEARS THE SMALL PLASTIC ROLLER (14) ON THE PRINTHEAD. AT THE SAME TIME, PIVOT SHAFT (16) PULLS BACK SWITCH ACTUATING PAWL (15) TO A NEW ENGAGEMENT POSITION ON THE SELECTOR SWITCH RATCHET (17).

AS THE CAM (8) IS FURTHER TURNED, THE CAM FOLLOWER (10) RIDES OUT OF THE CAM NOTCH (9) TO ADVANCE THE SELECTOR SWITCH, THE PRINT WHEEL, AND THE POINT (STATION) INDICATOR WHEEL TO THE NEXT STATION IN PREPARATION FOR MEASUREMENT OF THE NEWLY SELECTED STATION BY THE SERVO MEASUREMENT LOOP. THE MECHANICAL ACTIVITY UP TO THIS POINT IS DESCRIBED AS FOLLOWS:

(1) THE PRINTHEAD ACTUATING SHAFT (13) PUSHES ON THE PLASTIC ROLLER (14) OF THE PRINTHEAD AND BEGINS RAISING THE PRINTHEAD (11) FROM ITS LOWER PRINTING POSITION.

(2) THE SWITCH ACTUATING PAWL (15), THROUGH ITS ENGAGEMENT WITH THE SELECTOR SWITCH RATCHET (17), BEGINS TO DRIVE THE SELECTOR SWITCH SHAFT (18) FIFTEEN DEGREES TO THE NEXT POINT (STATION) POSITION. THIS MOTION OF THE SELECTOR SWITCH SHAFT IS DIRECTLY COUPLED TO THE SELECTOR SWITCH PINION (19) WHERE IT IS TRANSFERRED TO THE POINT (STATION) ADVANCE PINION (20) THROUGH THE 1:1 RATIO OF THE TWO IDLER GEARS (21 AND 22).

(3) AS THE PRINTHEAD (11) CONTINUES TO RISE FROM ITS LOWER PRINTING POSITION, THE LARGE IDLER GEAR (23) OF THE PRINTHEAD BEGINS MAKING CONTACT WITH THE POINT (STATION) ADVANCE PINION (20). WHEN THE PRINTHEAD HAS RISEN ABOUT ONE-THIRD OF ITS TOTAL UPWARD TRAVEL, THE PLAY IN THE IDLER GEAR DISAPPEARS. DUE TO THE SHAPE OF THE GEARBOX OUTPUT CAM (8), THE PRINTHEAD IS RAISED ABOUT 3/16" HIGHER (MEASURED AT THE FRONT) THAN ITS NORMALLY ATTAINED UPPER-REST POSITION.

(4) THE ROTATION OF POINT (STATION) ADVANCE PINION (20) AND THE EXTRA RISE OF THE PRINTHEAD (11) COMBINE TO DRIVE THE LARGE IDLER GEAR (23) OF THE PRINTHEAD. THE LARGE IDLER GEAR THEN DRIVES THE SMALL PINION GEAR (24) WHICH IN TURN IMPARTS DRIVE TO THE DETENT WHEEL (25). ROTATION OF THE DETENT WHEEL MOVES THE PEAK OF THE DETENT SPRING (26) ONTO THE TOP OF THE NEXT TOOTH IN THE DETENT WHEEL.

(5) AT THIS POINT THE TENSION OF THE DETENT SPRING (26) TAKES OVER AND DRIVES THE DETENT WHEEL (25) ABOUT SIX TO SEVEN DEGREES AHEAD IN THE SAME DIRECTION. THIS SLIGHT ROTATION OF THE DETENT WHEEL IS THEN DIRECTLY IMPARTED BACK TO THE LARGE IDLER GEAR (23) WHICH CAUSES THE LARGE IDLER GEAR TO DISENGAGE OR UNLOAD FROM THE POINT (STATION) ADVANCE PINION (20). PLAY CAN AGAIN BE FELT IN THE LARGE IDLER GEAR. THE ROTATION OF THE DETENT WHEEL IS LIKEWISE DIRECTLY COUPLED TO THE PRINT WHEEL SHAFT (27) WHEREBY THE PRINT WHEEL (28) IS ADVANCED TO THE NEXT POINT (STATION) NUMBER. THE MOTION OF THE DETENT WHEEL IS ALSO SIMULTANEOUSLY COUPLED THROUGH INTERMEDIATE GEARS (29, 30, 31, AND 32) TO THE INKING WHEEL SHAFT WHICH ADVANCES THE INKING WHEEL IN COINCIDENCE WITH THE NEXT NUMBER ON THE PRINT WHEEL.

(6) DURING STEPS 3, 4, AND 5, THE ROTATION OF THE POINT (STATION) ADVANCE PINION (20) ALSO IMPARTS DRIVE TO THE IDLER GEAR (34). THIS IDLER GEAR THEN DRIVES THE PINION (35). THE MOTION OF THE PINION (35) THEN DRIVES THE POINT (STATION) INDICATOR WHEEL (36) TO THE NEXT POINT NUMBER.

(7) AFTER THE CLICK OF THE DETENT SPRING (26) IS HEARD IN STEP 5, THE PRINTHEAD IS RAISED ABOUT ANOTHER 1/8" BEFORE DESCENDING TO ITS NORMALLY ATTAINED UPPER-REST POSITION. THIS ACTION ASSURES THE DISENGAGEMENT OF THE LARGE IDLER GEAR (23) FROM THE POINT (STATION) ADVANCE PINION (20) WHEN THE PRINTHEAD (11) EVENTUALLY DESCENDS TO

ITS NORMAL UPPER-REST POSITION. THE CLICK OF THE DETENT SPRING (26) SHOULD BE HEARD WHEN THE HIGHEST POINT OF THE GEARBOX OUTPUT CAM (8) IS ABOUT 1/16" FROM THE END OF THE CAM FOLLOWER (10). THE POINT ADVANCE PINION (20) CONTINUES TO ROTATE A FEW MORE DEGREES DURING THIS EXTRA RISE OF THE PRINTHEAD, BUT THE PINION (20) NO LONGER IMPARTS ANY DRIVE TO THE LARGE IDLER GEAR (23) IN THE PRINTHEAD AFTER THE DETENT CLICK.

(8) AS THE CAM FOLLOWER (10) PASSES THE HIGHEST PART OF THE LOBE ON THE GEARBOX OUTPUT CAM (8), THE SAME MOTION WHICH IS IMPARTED TO THE PRINTHEAD ACTUATING SHAFT (13) TO PRODUCE THE EXTRA RISE OF THE PRINTHEAD (11) IS ALSO IMPARTED TO THE PIVOT SHAFT (16). THE MOVEMENT OF THE PIVOT SHAFT IN TURN CAUSES THE SWITCH ACTUATING PAWL (15) TO DRIVE THE SELECTOR SWITCH RATCHET (17) SO THAT THE ROTARY SWITCH CONTACTS ARE POSITIONED ALL THE WAY OVER TO THE NEXT POINT (STATION) POSITION. THE PAWL (15) THEN DRAWS BACK ABOUT 1/32" AT THE SAME TIME THAT THE PRINTHEAD DESCENDS TO ITS NORMAL UPPER-REST POSITION. THIS ACTION TAKES PLACE ON THE SLOPE OF THE OUTPUT CAM (8).

(9) WHEN THE CAM FOLLOWER (10) REACHES THE POSITION WHERE THE SLOPED PART OF THE LOBE BLENDS INTO THE CIRCULAR PORTION OF THE LOBE ON THE GEARBOX OUTPUT CAM (8), THE SIGNAL CUT-OFF SWITCH (7) IS DE-ACTUATED BY THE SIGNAL CUT-OFF CAM (6). THE SERVO MEASUREMENT LOOP IS NOW IN READINESS TO MEASURE THE SIGNAL FROM THE NEWLY SELECTED POINT (STATION).

NOTE: THE ADJUSTMENT OF SEVERAL PARTS ARE PROVIDED TO INSURE PROPER MECHANICAL OPERATION OF THE PRINTING/INPUT SELECTION SYSTEM. REFER TO SECTION III (MAINTENANCE) OF PART 3.

PRINTHEAD: THE PRINTHEAD ASSEMBLY (FIGURE 3.3) IS IDENTICAL ON ALL VERSIONS OF THE E1124E RECORDER. THE PRINT WHEEL AND THE INKING WHEEL ARE NOT INCLUDED AS PART OF THE PRINTHEAD ASSEMBLY; THEY ARE INSTALLED AS INDIVIDUAL COMPONENTS AT THE FACTORY AND ARE IDENTIFIED BY THEIR RESPECTIVE PART NUMBERS ON THE INSTRUMENT DATA SHEET. THE PRINT WHEEL IS CHANGED IF IT IS DESIRED TO CHANGE THE NUMBER-OF-POINTS (-STATIONS) THAT ARE TO BE RECORDED. THE REQUIRED PRINT WHEEL FOR A PARTICULAR NUMBER-OF-POINTS (-STATIONS) CHANGE IS INCLUDED AS A PART OF THE VARIOUS POINT (STATION) CHANGE CONVERSION KITS. COMPLETE INFORMATION ON PROCEDURES FOR CHANGING THE NUMBER-OF-POINTS (-STATIONS) IS DESCRIBED IN SECTION III (MAINTENANCE) OF PART 3. CHANGING TO ANOTHER NUMBER-OF-POINT (-STATION) SELECTION MAY ALSO REQUIRE A REPLACEMENT OF THE MULTICOLOR INK WHEEL (NOT REQUIRED WHEN UNICOLOR INKING WHEEL IS USED). REFER TO SUBJECT ENTITLED "REPLACING MULTICOLOR INK WHEEL" IN SECTION III (MAINTENANCE) OF PART 3.

SECTION II OPERATION

GENERAL INFORMATION

This section of the manual contains the operating instructions applicable to the electro-mechanical servo system and the printing/input selection system employed in the Model E1124E Multipoint Recorder. Operating instructions for the chart drive are covered in PART 2 of this manual. Before preparing the instrument for operation, remove all packing materials and see that the case is properly installed.

No attempt should be made to operate the recorder until all instructions have been thoroughly studied. Failure to make the proper connections or to service the printing/input selection system properly may result in unsatisfactory operation or serious damage to the unit.

ELECTRICAL CONNECTIONS

Before making any electrical connections, refer to the TERMINAL CODE PLATE affixed to the rear of the reference voltage supply cover (on back of main mechanism swing-out frame inside case). This plate identifies the terminal number connections and input ratings (if applicable) for the power input and any optional equipment that is employed.

Power and Accessory Connections: Refer to SECTION III (Maintenance) of PART 3 for both the Power Wiring Diagram and the Accessory Wiring Diagram pertaining to the multipoint recorder. The Power Wiring Diagram for recorders optionally equipped with programmed printing is found in the supplemental instructions pertinent to the programmed printing option. See APPENDIX, PART 6.

The AC power input cord supplied on the recorder consists of a three-conductor configuration (line, neutral, and ground). It is of adequate wire size and insulating properties to capably handle the power requirements of the recorder. Plug the power cord into a polarized AC convenience outlet capable of delivering 120V AC (50/60Hz) at 90 VA.

The power input circuit is protected by a 2-ampere, slow-blow, 3AG cartridge-type fuse (F301, Figure 3.7).

Tie posts for the connection of optional accessories--such as retransmitting potentiometers, event pen, non-selective alarms, and chart drive remote control--are provided on the connection panel (CP301) of the terminal mounting plate assembly (see Figure 3.8). These tie posts are identified by numbers which correspond to the numbered connection points shown on the Accessory Wiring Diagram. No prescribed physical locations are required for the placement of the tie-point connectors (posts). They may be installed at random in any of the holes provided in the three-row configuration. The terminal connections of optional equipment are quickly identified on the TERMINAL CODE PLATE.

Signal Input Connections: As seen in Figure 3.2, the multiple-signal input panel (TB501) consists of 24 numbered pairs of terminals which provide the connections for up to 24 individual signal sources. The polarity marking which identifies each row of terminals should be strictly observed when connecting the signal input leads. The signal input leads may be routed through any of the convenient knock-out holes in the case.

RANGE CARD CONNECTIONS:

(1) A ZERO MILLIVOLT BASE RANGE CARD CONNECTS ACROSS TERMINALS 6 THROUGH 11 OF TB201.

(2) ZERO-SUPPRESSED, ZERO-ELEVATED MILLIVOLT BASE RANGE CARDS AND THERMOCOUPLE RANGE CARDS CONNECT ACROSS TERMINALS 4 THROUGH 11 OF TB201.

*(3) A VOLTAGE DIVIDER CARD CONNECTS ACROSS TERMINALS 2, 3, AND 5 OF TB201.

†(4) A CURRENT SHUNT CARD CONNECTS ACROSS TERMINALS 2 AND 3 OF TB201.

*A VOLTAGE DIVIDER CARD IS USED IN CONJUNCTION WITH A MILLIVOLT RANGE CARD (EITHER ZERO BASED, ZERO SUPPRESSED, OR ZERO ELEVATED) FOR DC-VOLT MEASUREMENT RANGES.

†A CURRENT SHUNT CARD IS USED IN CONJUNCTION WITH A MILLIVOLT RANGE CARD (EITHER ZERO BASED, ZERO SUPPRESSED, OR ZERO ELEVATED) FOR DC-CURRENT MEASUREMENT RANGES.

AMPLIFIER CONNECTION TERMINAL BLOCK (TB201)
JUMPER LINK CONNECTS BETWEEN TERMINALS 2 AND 4 OF TB201 WHEN A ZERO MILLIVOLT BASE RANGE CARD IS USED
FUSE (F301)
RETAINING SCREW
TERMINAL MOUNTING PLATE ASSEMBLY (HOUSES CONNECTION TERMINALS FOR POWER INPUT AND OPTIONAL EQUIPMENT. SEE FIGURE 3.8).

FIGURE 3.7. LOCATION OF TERMINAL CONNECTIONS WITHIN THE RECORDER CASE.

CAUTION: TO AVOID POSSIBLE INTERFERENCE, DO NOT ROUTE SIGNAL LEADS ADJACENT TO POWER INPUT CORD OR THROUGH THE SAME KNOCK-OUT HOLE WHICH IS USED TO ROUTE THE POWER INPUT CORD.

STANDOFF AND STUD ASSEMBLIES ARE USED AT EACH OF THE FOUR MOUNTING CORNERS OF THE SIGNAL INPUT PANEL (TB501) TO COMPLETELY INSULATE (FLOAT) THE INPUT PANEL FROM THE INSTRUMENT CASE. THE INPUT PANEL CABLE LEADS WHICH CONNECT TO AMPLIFIER TERMINAL BLOCK TB201 ARE SHIELDED WITH THE SHIELD WIRE CONNECTED TO THE INPUT PANEL BOTTOM COVER AND TO TERMINAL NUMBER 1 ON TB201. THESE CONNECTIONS OF THE SIGNAL INPUT CIRCUITRY ARE SHOWN ON THE SCHEMATIC IN FIGURE 3.27. THE GROUNDING AND SHIELDING CONFIGURATION OF THE INPUT CIRCUITRY, COUPLED WITH THE FLOATING ARRANGEMENT OF THE INPUT PANEL AND AMPLIFIER, COMPLETELY FLOATS THE INPUT AND SIGNAL-CONDITIONING CIRCUITS WITH RESPECT TO THE INSTRUMENT CASE OR SYSTEM GROUND (///).

THE INPUT PANEL MAY BE PREWIRED IN DIFFERENT WAYS TO CONFORM TO THE NUMBER-OF-POINT INPUT SELECTION SPECIFIED BY THE USER.

IF THE USER SPECIFIES A FIXED NUMBER-OF-POINT SELECTION, THE NUMBER-OF-POINTS PLUG (P301) AND NUMBER-OF-POINTS SOCKET (J301) ARE NOT USED; AND THE INPUT PARALLELING OF POINTS WHICH CONSTITUTES A FIXED POINT WIRING SYSTEM IS DONE AT THE FACTORY. INPUT PANELS WIRED FOR A CERTAIN FIXED NUMBER-OF-POINTS CANNOT BE READILY CHANGED TO A DIFFERENT NUMBER-OF-POINT SELECTION IN THE FIELD.

IF THE USER DESIRES THE OPTION OF READILY CHANGING HIS NUMBER-OF-POINT SELECTION IN THE FIELD, A NUMBER-OF-POINTS PLUG (P301) AND NUMBER-OF-POINTS SOCKET (J301) ARE INCLUDED AS PART OF THE INPUT PANEL WIRING. PLUGGING THE POINTS SOCKET INTO THE POINTS PLUG ON THE PANEL ACCOMPLISHES THE POINT PARALLELING SO THAT A NUMBER-OF-POINT SELECTION LESS THAN 24 CAN BE ACCOMMODATED.

THE NUMBER-OF-POINT SOCKETS ARE AVAILABLE FOR 2, 3, 4, 6, 8, 10, 12, 16, 18, 20, AND 24 POINTS. FOR A 24-POINT INPUT SELECTION, A DUST COVER IS PLACED OVER THE POINTS PLUG (P301). IN THIS MANNER, ALL POINT (STATION) INPUT TERMINALS REMAIN ISOLATED FROM EACH OTHER TO ENABLE A 24-POINT INPUT SELECTION. WHEN ANY ONE OF THE PARTICULAR POINTS SOCKETS (LISTED ABOVE) LESS THAN 24 IS INSERTED, THE PARTICULAR SOCKET IS PREWIRED SO THAT SPECIFIC PAIRS OF INPUT TERMINALS ARE EFFECTIVELY CONNECTED IN PARALLEL, THUS CHANGING THE NUMBER-OF-POINT SELECTION TO THE NUMBER INDICATED ON THE POINTS SOCKET (SEE TABLE 3.9).

OBSERVE PROCEDURES DESCRIBED UNDER TOPIC HEADING "SHIELDING AND GROUNDING" UNDER MAIN HEADING REJECTION OF INTERFERENCE AND MAKE SIGNAL INPUT CONNECTIONS TO INPUT PANEL TB501 AS FOLLOWS:

(1) Remove four screws from top cover of input panel. Remove top cover to expose connection terminals.

(2) Connect input signals to appropriate point terminals on input panel.

NOTE: If input selection system is wired for less than 24 points, refer to Table 3.9 to determine those point terminals which are to have signal connections and those terminals which are to be left open.

(3) Dress all signal input connections on panel so that wiring is routed through rectangular cutout formed between top and bottom covers when top cover is mounted in place to enclose the connection panel.

(4) Replace and tighten the four top cover retaining screws.

Amplifier Terminal Block (TB201) Connections: Range card connections to the amplifier terminal block (TB201) are illustrated in Figure 3.7. Signal input connections and other miscellaneous connections to TB201 are illustrated in Figures 3.9 and 3.9-1.

As shown in Figure 3.9, terminal 1 of TB201 connects to "common" or "floating signal" ground of the amplifier; terminal 2 is the "LO" (-) signal input connection; terminal 3 is the "HI" (+) signal input connection. The left- and right-hand mounting screws of TB201 connect to the amplifier chassis ground.

The case ground is connected to building or earth ground through the ground conductor in the 3-wire power cord. Connections to these terminals on the amplifier terminal block (TB201) may be employed in various ways to reduce interference. See topic heading "Shielding and Grounding" under "REJECTION OF INTERFERENCE".

NOTE: Amplifier chassis ground (⏚) and "signal floating" ground (▽) are electrically the same reference ground point. The amplifier chassis, however, is mounted on stand-off insulators to electrically insulate (float) the amplifier from the instrument case ground (⏚).

NOTE: When range changing procedures are involved, refer to topic heading RANGE CHANGING in Electrical Section (Section III) of PART 3. Also refer to Figure 3.24-1 for making proper connections to amplifier terminal block.

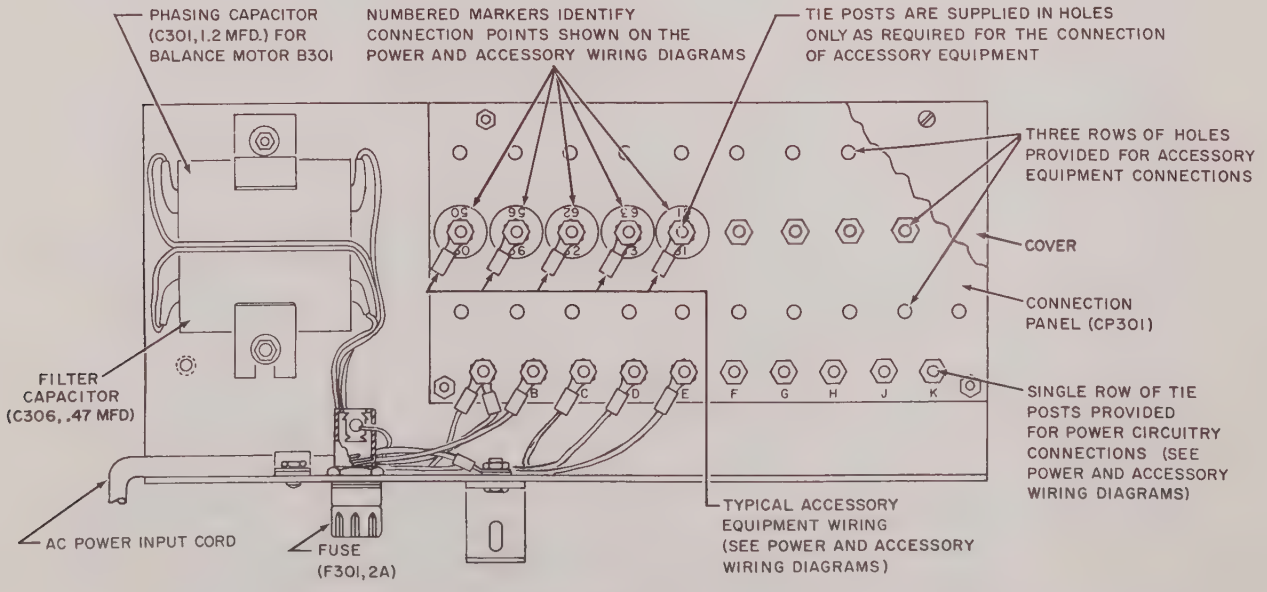

PHASING CAPACITOR (C301, 1.2 MFD.) FOR BALANCE MOTOR B301
NUMBERED MARKERS IDENTIFY CONNECTION POINTS SHOWN ON THE POWER AND ACCESSORY WIRING DIAGRAMS
TIE POSTS ARE SUPPLIED IN HOLES ONLY AS REQUIRED FOR THE CONNECTION OF ACCESSORY EQUIPMENT
THREE ROWS OF HOLES PROVIDED FOR ACCESSORY EQUIPMENT CONNECTIONS
COVER
CONNECTION PANEL (CP301)
SINGLE ROW OF TIE POSTS PROVIDED FOR POWER CIRCUITRY CONNECTIONS (SEE POWER AND ACCESSORY WIRING DIAGRAMS)
FILTER CAPACITOR (C306, .47 MFD)
AC POWER INPUT CORD
FUSE (F301, 2A)
TYPICAL ACCESSORY EQUIPMENT WIRING (SEE POWER AND ACCESSORY WIRING DIAGRAMS)
A
B
C
D
E
F
G
H
J
K

FIGURE 3.8. TERMINAL MOUNTING PLATE CONNECTION TERMINALS.

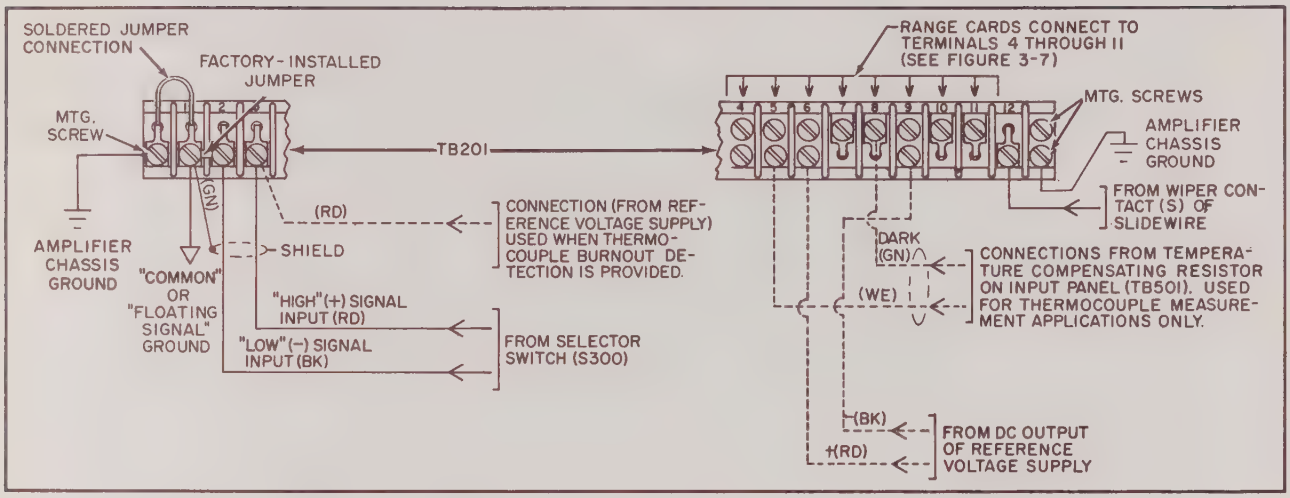

SOLDERED JUMPER CONNECTION
FACTORY-INSTALLED JUMPER
MTG. SCREW
TB201
RANGE CARDS CONNECT TO TERMINALS 4 THROUGH 11 (SEE FIGURE 3-7)
MTG. SCREWS
AMPLIFIER CHASSIS GROUND
FROM WIPER CONTACT (S) OF SLIDEWIRE
(GN)
(RD)
CONNECTION (FROM REFERENCE VOLTAGE SUPPLY) USED WHEN THERMOCOUPLE BURNOUT DETECTION IS PROVIDED.
AMPLIFIER CHASSIS GROUND
SHIELD
"COMMON" OR "FLOATING SIGNAL" GROUND
"HIGH" (+) SIGNAL INPUT (RD)
"LOW" (-) SIGNAL INPUT (BK)
FROM SELECTOR SWITCH (S300)
DARK (GN)
(WE)
CONNECTIONS FROM TEMPERATURE COMPENSATING RESISTOR ON INPUT PANEL (TB501). USED FOR THERMOCOUPLE MEASUREMENT APPLICATIONS ONLY.
(BK)
(RD)
FROM DC OUTPUT OF REFERENCE VOLTAGE SUPPLY

FIGURE 3.9. AMPLIFIER TERMINAL BLOCK (TB201) CONNECTIONS.

INTERFERENCE VOLTAGES

Interference is any spurious voltage or current appearing in the input measuring circuit. Normal mode (sometimes called transverse or differential) interference can appear across the signal input leads, while common or longitudinal mode appears from either input lead to ground. These voltages--DC, AC, or just random noise--can vary in amplitude from a small fraction of the incoming signal to many times its value. Usually, both types are present to some degree.

The presence of excessive noise (stray pickup) may be indicated by a constant excessive vibration of the servo system, excessive deadband, zero shift, or any combination of these effects. Not all interference causes servo vibration because it may not be phased correctly to produce balancing motor torque. Nevertheless, all interference tends to saturate the amplifier with a useless signal that makes the amplifier much less sensitive to the changes in the desired signal. Some common sources of stray pickup are as follows:

(1) Running the signal input leads near a transformer or high-powered electrical machinery.

(2) Paralleling signal input leads close to 120-volt, 60-cycle power lines--particularly running them in the same conduit.

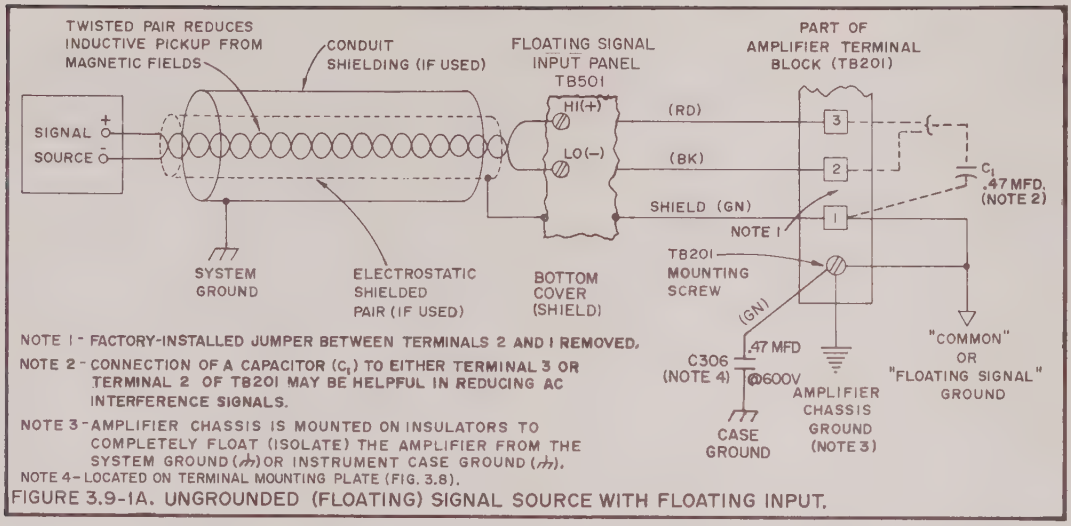
(3) An AC signal from a transformer secondary which has been rectified to DC but not properly filtered. This situation generates capacitive stray which may be picked up.

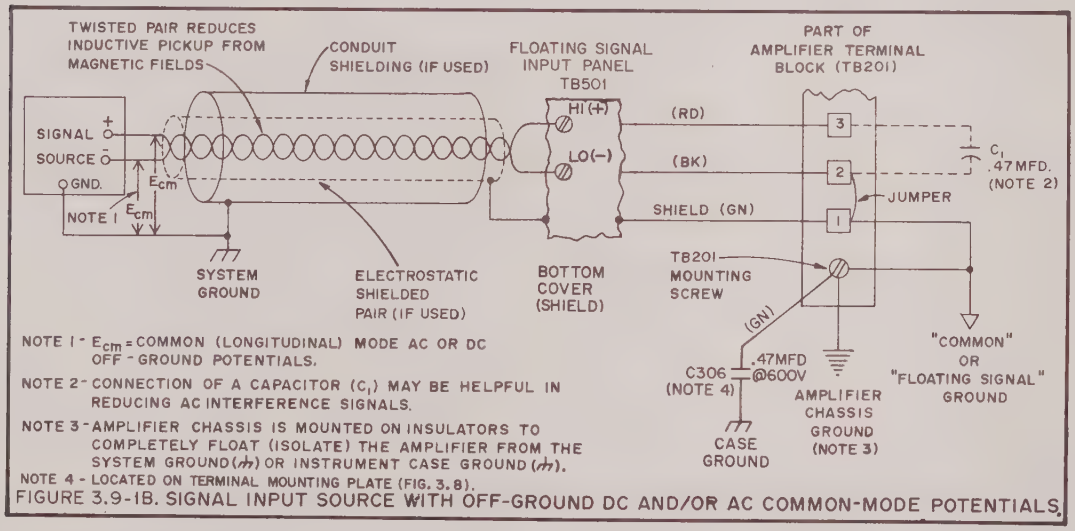
(4) Any conditions where the thermocouple tip is in direct contact with voltage above ground, or even where there is mutual coupling without direct contact.

(5) Transmission line effects--such as distributed inductance, capacitance, and leakage to ground--are sources of strays which become increasingly larger with longer lines.

(6) Common impedance coupling ground-loops. Placing more than one ground on a signal circuit produces a ground-loop which may generate so much noise that it may completely obscure a useful signal.

(7) Inadequate common-mode rejection. Common-mode signals, common-mode voltages, and in-phase signals are all basically the same thing. This is simply a signal which appears simultaneously at the signal input terminals with respect to a common reference point (ground). It is an unwanted noise signal which must be rejected without disturbing the measurement signal.


TWISTED PAIR REDUCES INDUCTIVE PICKUP FROM MAGNETIC FIELDS
CONDUIT SHIELDING (IF USED)
FLOATING SIGNAL INPUT PANEL TB501
PART OF AMPLIFIER TERMINAL BLOCK (TB201)
SIGNAL SOURCE
HI(+)
LO(-)
(RD)
(BK)
SHIELD (GN)
NOTE 1
C1 .47 MFD. (NOTE 2)
SYSTEM GROUND
ELECTROSTATIC SHIELDED PAIR (IF USED)
BOTTOM COVER (SHIELD)
TB201 MOUNTING SCREW
(GN)
C306 (NOTE 4)
.47 MFD @600V
"COMMON" OR "FLOATING SIGNAL" GROUND
AMPLIFIER CHASSIS GROUND (NOTE 3)
CASE GROUND
NOTE 1 - FACTORY-INSTALLED JUMPER BETWEEN TERMINALS 2 AND 1 REMOVED.
NOTE 2 - CONNECTION OF A CAPACITOR (C1) TO EITHER TERMINAL 3 OR TERMINAL 2 OF TB201 MAY BE HELPFUL IN REDUCING AC INTERFERENCE SIGNALS.
NOTE 3 - AMPLIFIER CHASSIS IS MOUNTED ON INSULATORS TO COMPLETELY FLOAT (ISOLATE) THE AMPLIFIER FROM THE SYSTEM GROUND (⏚) OR INSTRUMENT CASE GROUND (⏚).
NOTE 4 - LOCATED ON TERMINAL MOUNTING PLATE (FIG. 3.8).
FIGURE 3.9-1A. UNGROUNDED (FLOATING) SIGNAL SOURCE WITH FLOATING INPUT.


TWISTED PAIR REDUCES INDUCTIVE PICKUP FROM MAGNETIC FIELDS
CONDUIT SHIELDING (IF USED)
FLOATING SIGNAL INPUT PANEL TB501
PART OF AMPLIFIER TERMINAL BLOCK (TB201)
SIGNAL SOURCE
GND.
Ecm
NOTE 1
HI(+)
LO(-)
(RD)
(BK)
SHIELD (GN)
JUMPER
C1 .47MFD. (NOTE 2)
SYSTEM GROUND
ELECTROSTATIC SHIELDED PAIR (IF USED)
BOTTOM COVER (SHIELD)
TB201 MOUNTING SCREW
(GN)
C306 (NOTE 4)
.47MFD @600V
"COMMON" OR "FLOATING SIGNAL" GROUND
AMPLIFIER CHASSIS GROUND (NOTE 3)
CASE GROUND
NOTE 1 - Ecm = COMMON (LONGITUDINAL) MODE AC OR DC OFF-GROUND POTENTIALS.
NOTE 2 - CONNECTION OF A CAPACITOR (C1) MAY BE HELPFUL IN REDUCING AC INTERFERENCE SIGNALS.
NOTE 3 - AMPLIFIER CHASSIS IS MOUNTED ON INSULATORS TO COMPLETELY FLOAT (ISOLATE) THE AMPLIFIER FROM THE SYSTEM GROUND (⏚) OR INSTRUMENT CASE GROUND (⏚).
NOTE 4 - LOCATED ON TERMINAL MOUNTING PLATE (FIG. 3.8).
FIGURE 3.9-1B. SIGNAL INPUT SOURCE WITH OFF-GROUND DC AND/OR AC COMMON-MODE POTENTIALS.

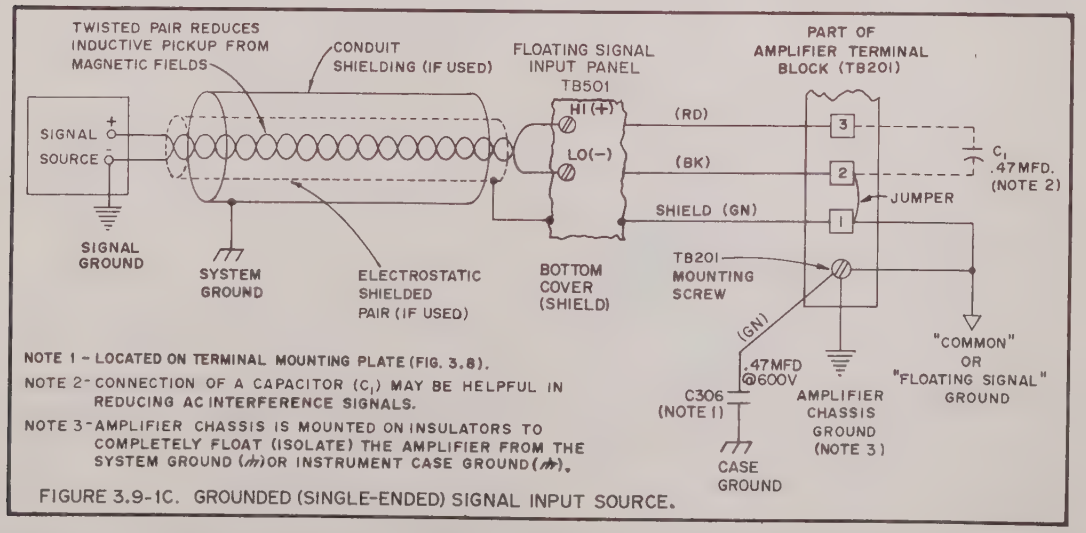

TWISTED PAIR REDUCES INDUCTIVE PICKUP FROM MAGNETIC FIELDS
CONDUIT SHIELDING (IF USED)
FLOATING SIGNAL INPUT PANEL TB501
PART OF AMPLIFIER TERMINAL BLOCK (TB201)
SIGNAL SOURCE
SIGNAL GROUND
HI(+)
LO(-)
(RD)
(BK)
SHIELD (GN)
JUMPER
C1 .47MFD. (NOTE 2)
SYSTEM GROUND
ELECTROSTATIC SHIELDED PAIR (IF USED)
BOTTOM COVER (SHIELD)
TB201 MOUNTING SCREW
(GN)
C306 (NOTE 1)
.47MFD @600V
"COMMON" OR "FLOATING SIGNAL" GROUND
AMPLIFIER CHASSIS GROUND (NOTE 3)
CASE GROUND
NOTE 1 - LOCATED ON TERMINAL MOUNTING PLATE (FIG. 3.8).
NOTE 2 - CONNECTION OF A CAPACITOR (C1) MAY BE HELPFUL IN REDUCING AC INTERFERENCE SIGNALS.
NOTE 3 - AMPLIFIER CHASSIS IS MOUNTED ON INSULATORS TO COMPLETELY FLOAT (ISOLATE) THE AMPLIFIER FROM THE SYSTEM GROUND (⏚) OR INSTRUMENT CASE GROUND (⏚).
FIGURE 3.9-1C. GROUNDED (SINGLE-ENDED) SIGNAL INPUT SOURCE.

FIGURE 3.9-1. TYPICAL SIGNAL INPUT (TB501) AND AMPLIFIER TERMINAL BLOCK (TB201) CONNECTIONS.

THE CONDITIONS PRODUCING THE INTERFERENCE CAN ALMOST ALWAYS BE ELIMINATED BY PROPER SHIELDING, GROUNDING, AND CIRCUIT DRESSING TECHNIQUES.

REJECTION OF INTERFERENCE

IN THE MODEL E1124E, THE USE OF THE INPUT TRANSFORMER (T201) WITH THE CHOPPER PROVIDES DC ISOLATION BETWEEN THE INPUT MEASURING CIRCUIT AND THE AMPLIFYING CIRCUITS. THE AMPLIFYING CIRCUITS BEGIN AT THE SECONDARY OF T201. THE USE OF AN ELECTROSTATIC SHIELD IN T201 ASSURES THAT THERE WILL BE NO UNWANTED CAPACITIVE (AC) COUPLING BETWEEN THE INPUT MEASURING CIRCUIT AND THE AMPLIFYING CIRCUITS. GENERALLY, THIS ISOLATION SHOULD BE MAINTAINED AS LONG AS ADEQUATE REJECTION OF INTERFERENCE CAN BE ACHIEVED. THE ISOLATED (FLOATING) INPUT CIRCUIT PROVIDES A FIRM BASE FOR THE REJECTION OF UNWANTED COMMON-MODE NOISE.

ALTHOUGH INTERFERENCE IS SELDOM COMPLETELY ABSENT FROM THE INPUT CIRCUIT, THE INPUT FILTER IN THE MEASURING CIRCUIT IS OFTEN SUFFICIENT TO REJECT SUCH INTERFERENCE TO A SATISFACTORY DEGREE. BEING TUNABLE, THE FILTER DISCRIMINATES MOST STRONGLY AGAINST POWER-FREQUENCY INTERFERENCE SIGNALS. HOWEVER, INSTANCES MAY OCCUR WHEN THE INTERFERENCE IS TOO STRONG TO BE ADEQUATELY ELIMINATED BY THE FILTER ALONE.

CAUTION: THE FILTER HAS BEEN CAREFULLY ADJUSTED AT THE FACTORY AND SHOULD NOT BE INADVERTENTLY CHANGED UNLESS POSITIVELY IDENTIFIED AS THE REASON FOR EXCESSIVE INTERFERENCE. THE ADJUSTMENT OF THE FILTER CONTROLS IS COVERED IN SECTION III (MAINTENANCE) OF PART 3.

GUIDELINES ON GROUNDING: BY DEFINITION, A GROUND IS A POINT OF UNVARYING POTENTIAL. EVERY CONVENTIONAL ELECTRICAL POWER CIRCUIT IS GROUNDED ON THE NEUTRAL SIDE TO EARTH GROUND. ALL LOW-LEVEL MEASUREMENT AND RECORDING SYSTEMS SHOULD BE PROVIDED WITH A STABLE SYSTEM (EARTH OR BUILDING) GROUND TO ASSURE THAT ALL ELECTRONIC ENCLOSURES AND CHASSIS OPERATING IN AN ELECTROMAGNETIC ENVIRONMENT ARE MAINTAINED AT ZERO POTENTIAL. STABLE, LOW-IMPEDANCE SYSTEM GROUNDING IS NECESSARY TO ATTAIN EFFECTIVE SHIELDING OF LOW-LEVEL CIRCUITS, TO PROVIDE A STABLE REFERENCE FOR MAKING VOLTAGE MEASUREMENTS, AND TO ESTABLISH A SOLID BASE FOR THE REJECTION OF UNWANTED COMMON-MODE SIGNALS.

BESIDES A STABLE SYSTEM (EARTH) GROUND, THE "SIGNAL" OR "COMMON" GROUND IS ALSO ESSENTIAL IN THE MEASUREMENT OF LOW-LEVEL SIGNAL APPLICATIONS. THE SIGNAL GROUND SYSTEM IS NECESSARY TO INSURE A LOW-NOISE SIGNAL REFERENCE TO GROUND. THIS GROUND SHOULD BE A LOW-IMPEDANCE CIRCUIT AND PROVIDE A SOLID REFERENCE TO ALL LOW-LEVEL SIGNAL SOURCES--THUS MINIMIZING THE INTRODUCTION OF SPURIOUS VOLTAGES INTO THE SIGNAL CIRCUITS. THE SIGNAL GROUND SHOULD BE INSULATED FROM OTHER GROUNDING SYSTEMS, AND IT IS GENERALLY UNDESIRABLE TO CONNECT IT TO THE SYSTEM (EARTH) GROUND AT ANY POINT. AFTER ATTAINING THE NECESSARY STABILITY IN THE SIGNAL GROUND, THE MOST IMPORTANT POINT TO REMEMBER IS THAT A SIGNAL CIRCUIT SHOULD ONLY BE GROUNDED AT ONE POINT.

SIGNAL INPUT CIRCUIT POINTS WHICH ARE REFERENCED TO A GROUND SYSTEM MAY BE TERMED EITHER AC-GROUNDED OR DC-GROUNDED. A GROUND POINT FOR DC OR AC MAY BE MADE TO THE GROUNDING SYSTEM (EITHER SYSTEM GROUND OR SIGNAL GROUND) THROUGH A SOLID CONDUCTOR. THE AC-GROUNDING OF A POINT TO GROUND CAN ALSO BE ACCOMPLISHED BY A CAPACITOR OF RELATIVELY LOW CAPACITIVE REACTANCE, BUT THE SAME CAPACITOR MAY ALSO BE USED TO ISOLATE A DC POTENTIAL FROM GROUND. IN THIS MANNER, IT IS OFTEN DESIRABLE IN THE REJECTION OF INTERFERENCE TO USE CAPACITORS IN AC-GROUNDING OF A SIGNAL CIRCUIT WHILE AT THE SAME TIME KEEPING THE SIGNAL CIRCUIT DC-ISOLATED FROM GROUND.

THE FOLLOWING ARE SOME RULES ON RECOMMENDED GROUNDING PROCEDURES WHICH WILL HELP TO ELIMINATE INTERFERENCE PROBLEMS.

(1) INTENTIONAL OR ACCIDENTAL GROUND-LOOPS IN EITHER THE SIGNAL CIRCUIT OR THE SIGNAL CABLE SHIELD WILL USUALLY DESTROY THE OPERATION OF ANY LOW-LEVEL DATA SYSTEM.

(2) EVERY LOW-LEVEL DATA SYSTEM SHOULD HAVE A STABLE SYSTEM GROUND (BUILDING OR EARTH GROUND) AND A GOOD SIGNAL (COMMON) GROUND.

(3) A SIGNAL CABLE SHIELD SHOULD NOT BE ATTACHED TO MORE THAN ONE GROUNDING SYSTEM.

(4) A SIGNAL CIRCUIT SHOULD BE GROUNDED ONLY AT ONE POINT.

Signal Ground and System Ground

Amplifier Signal Ground: All circuit return paths of the amplifier printed circuit board are interconnected together into one circuit reference point termed the "floating signal" ground (⏚). The "floating signal" ground of the printed circuit board, in turn, is connected to the amplifier chassis ground (⏚) through the mounting screws of the amplifier terminal block TB201. The amplifier assembly is mounted on insulators to completely float (isolate) the amplifier from the system ground or instrument case ground (⏚). This floating arrangement of the amplifier provides optimum rejection of interference signals.

System (Building or Earth) Ground: The instrument case is connected to the system ground (⏚) through the ground conductor in the 3-wire power cord.

Shielding and Grounding: To prevent noise pickup from electrostatic or magnetic fields, the low-level signal input leads routed to the signal input panel (TB501) should be surrounded by an effective shield.

If rigid or flexible conduit shielding is used (Figure 3.9-1A), the conduit should be connected to a stable system (earth) ground. Both iron and copper conduit shield against electrostatic (capacitive coupling) interference. Only iron conduit (not copper) shields against magnetic pickup. Twisting the signal input leads also helps to reduce the interference voltages induced by magnetic fields.

If the shield is an integral part of the signal cable, it should also be grounded as shown in Figures 3.9-1A, 3.9-1B, and 3.9-1C.

As illustrated in Figures 3.9, 3.9-1B, and 3.9-1C, the recorder is shipped with a jumper connected between terminal 1 ("common") and terminal 2 ("LO" side of signal input) of the amplifier terminal block TB201. This connection is often helpful in suppressing interference; but, as shown in Figure 3.9-1B, any off-ground potentials present on the signal source will also be placed on "common."

WARNING: When operating with off-ground potentials present on "common," care should be exercised to avoid shock to person and possible damaging shorts to the equipment. A warning decal, stating that the amplifier chassis floats at a common-mode potential with respect to the instrument case, is attached to the top of the amplifier. Common-mode, floating potentials should not exceed 120-volts AC or 300-volts DC with respect to the instrument case ground (⏚).

As shown in Figure 3.9-1, capacitor C306 connects between the mounting screw of TB201 (amplifier chassis ground ⏚) and the instrument case ground (⏚). Capacitor C306 serves to ground stray off-ground AC voltages which may be present on the amplifier chassis ("low" side of signal source); and also it maintains DC isolation for off-ground DC potentials which may exist on the amplifier chassis ("low" side of signal source). To AC isolate (float) the amplifier chassis from case ground, remove one end of capacitor C306 (green wire) that connects to the mounting screw of TB201.

FUNCTIONS OF OPERATOR CONTROLS

All of the operator controls--with the exception of the point (station) advance control (see Figure 3.11)--are accessible from the front of the amplifier as shown in Figure 3.10. These controls are screwdriver adjustments and may be adjusted in the field to obtain optimum response characteristics of the recorder.

All adjustments are set at the factory and normally should not require readjustment in the field. However, if readjustment becomes necessary or if it is desired to check the adjustment, refer to topic heading OPERATOR CONTROL ADJUSTMENT PROCEDURES in this section of the manual.

CAUTION: THE ZERO CONTROL, WHICH IS ALSO ACCESSIBLE FROM THE FRONT OF THE AMPLIFIER, IS NOT TREATED AS AN OPERATOR CONTROL. THE ZERO CONTROL, IN CONJUNCTION WITH THE SPAN AND COMP CONTROLS (SPAN AND COMP CONTROLS LOCATED ON THE REFERENCE VOLTAGE SUPPLY MODULE ON REAR OF MAIN FRAME MECHANISM--SEE FIGURE 3.22-1), IS USED TO PRECISELY CALIBRATE THE MEASURING SPAN OF THE INSTRUMENT. ADJUSTMENT PROCEDURES FOR THE ZERO, COMP, AND SPAN CONTROLS ARE OUTLINED UNDER TOPIC HEADING "RECORDER CALIBRATION" IN THE ELECTRICAL MAINTENANCE SECTION (SECTION III) OF PART 3.

UNDER TYPICAL OPERATING CONDITIONS, THE INSTRUMENT SHOULD BE ADJUSTED TO PERFORM WITH A JITTER-FREE RESPONSE, WITH OPTIMAL DAMPING, AND WITH MINIMUM DEADBAND. TO ASSIST THE OPERATOR IN INTERPRETING THE EFFECTS OF HIS ADJUSTMENTS, SEVERAL OF THE TERMS DEFINING RECORDER PERFORMANCE ARE AS FOLLOWS:

RESPONSE TIME: THIS TERM REFERS TO THE PERIOD OF TIME REQUIRED FOR THE RECORDER TO RESPOND TO A GIVEN CHANGE IN THE MEASURED SIGNAL LEVEL. DURING THIS TIME, THE APPLIED SIGNAL MUST EFFECT A CHANGE IN THE GRAPHIC RECORD WITHIN ACCURACY SPECIFICATIONS (0.25% OF SPAN) OF THE INSTRUMENT. THE RESPONSE TIMES FOR THE MULTIPOINT RECORDER ARE AVAILABLE IN THE STANDARD FULL-SPAN RESPONSE SPEEDS OF 0.5, 1, 4, OR 20 SECONDS. A JITTER-FREE RESPONSE IS ONE WHICH DOES NOT EXHIBIT PRINTHEAD OSCILLATIONS CAUSED BY EXCESSIVE AMPLIFIER GAIN OR INTERFERENCE.

CRITICALLY DAMPED: THIS CONDITION EXISTS WHEN THE INSTRUMENT ACCURATELY RESPONDS TO AN INSTANTANEOUS NEAR FULL-SPAN CHANGE IN THE APPLIED SIGNAL WITH A MAXIMUM STEP-RESPONSE SPEED AND A MINIMUM OVERSHOOT. THE MINIMUM OVERSHOOT TOLERANCE OF THE MULTIPOINT CAN BE ADJUSTED SO THAT IT DOES NOT EXCEED 0.25% OF SPAN. HOWEVER, THE DAMPING REQUIREMENTS OF THE MULTIPOINT ARE NOT THIS CRITICAL SINCE THE PRINTHEAD DOES NOT TRACE OUT THE OVERSHOOT; THEREFORE, AN OVERSHOOT WITHIN 5% OF SPAN IS PERMISSIBLE. SEE "OPERATOR CONTROL ADJUSTMENT PROCEDURES."

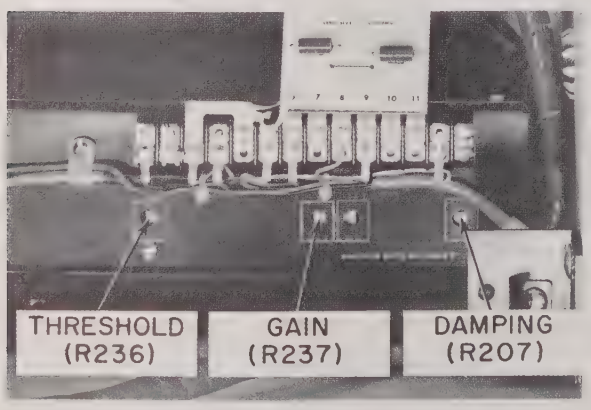


FIGURE 3.10. LOCATION OF OPERATING CONTROLS.

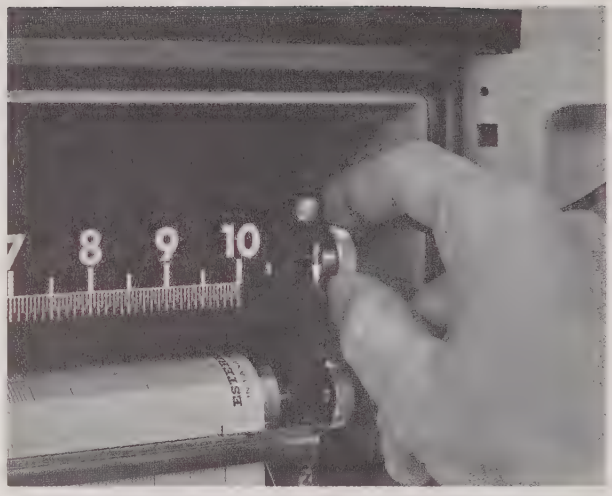


FIGURE 3.11. OPERATING POINT (STATION) ADVANCE.

DEADBAND: THIS PERFORMANCE CHARACTERISTIC IS DIRECTLY RELATED TO THE MAXIMUM SENSITIVITY OF THE RECORDER. DEADBAND IS REPRESENTED BY THAT RANGE THROUGH WHICH THE MEASURED SIGNAL CAN BE VARIED WITHOUT INITIATING ANY RESPONSE. DEADBAND IS USUALLY EXPRESSED IN "PERCENT OF SPAN" AND NORMALLY RESULTS FROM INHERENT MECHANICAL FRICTIONS OF THE SERVO SYSTEM. SINCE THE PRINTHEAD MAY MOVE IN EITHER OF TWO LATERAL DIRECTIONS, BOTH DIRECTIONS CONTRIBUTE TO DEADBAND. CONSEQUENTLY, FOR ANY GIVEN INPUT SIGNAL, THE EFFECTIVE ERROR VALUE WILL BE ONLY HALF OF THE TOTAL DEADBAND DISPLACEMENT. THE DEADBAND TOLERANCE OF THE MULTIPOINT SHOULD BE ADJUSTED WITHIN 0.1% OF SPAN.

OPERATOR CONTROLS

GAIN CONTROL (R237): THIS CONTROL ADJUSTS THE AMPLITUDE OR LEVEL OF THE AC ERROR SIGNAL IN THE MEASURING CIRCUIT. INSUFFICIENT GAIN WILL CAUSE EXCESSIVE DEADBAND, AND THE PRINTHEAD MAY NOT REACH THE POSITION CALLED FOR BY THE INPUT

SIGNAL BEFORE PRINTING TAKES PLACE. EXCESSIVE GAIN WILL ENABLE THE PRINTHEAD TO ARRIVE AT THE CALLED-FOR POSITION PROMPTLY BUT WILL ALSO CAUSE A SMALL AMPLITUDE OSCILLATION ABOUT SYSTEM NULL. SINCE PRINTING MAY TAKE PLACE AT ANY POINT WITHIN THE RANGE OF THE OSCILLATION, EXCESSIVE GAIN WILL CAUSE INACCURATE READINGS AND POOR REPEATABILITY.

THRESHOLD CONTROL (R236): THE ADJUSTMENT OF THIS CONTROL GOVERNS THE OVERALL SENSITIVITY OF THE AMPLIFIER. IMPROPER ADJUSTMENT OF THE THRESHOLD CAN CAUSE THE SAME EFFECTS ON THE DYNAMIC RESPONSE OF THE INSTRUMENT AS OUTLINED ABOVE UNDER GAIN CONTROL.

DAMPING CONTROL (R207): THE DAMPING CONTROL IS CONNECTED IN SERIES WITH THE MEASURED SIGNAL AND IS ADJUSTED TO PREVENT EXCESSIVE OVERSHOOT. IT SHOULD NOT BE ADJUSTED SO HIGH THAT THE RESPONSE BECOMES TOO SLUGGISH. MODERATE OVERSHOOT IS PERMISSIBLE ON LONG EXCURSIONS OF THE PRINTHEAD AS LONG AS THE SERVO SETTLES DOWN BEFORE PRINT-OUT AND HAS GOOD REPEATABILITY. AN OVERSHOOT WITHIN 5% OF SPAN IS PERMISSIBLE. SEE "OPERATOR CONTROL ADJUSTMENT PROCEDURES."

POINT (STATION) ADVANCE CONTROL: OPERATING THIS CONTROL, AS SHOWN IN FIGURE 3.11, QUICKLY PERMITS THE OPERATOR TO MANUALLY ADVANCE TO A DESIRED POINT (STATION) FOR MONITORING ITS MEASURED VALUE RATHER THAN HAVING TO WAIT FOR THE NORMAL MODE THROUGH WHICH THE SAME DESIRED POINT (STATION) IS SELECTED AUTOMATICALLY. THE NUMBER OF THE DESIRED POINT (STATION) IS INDICATED THROUGH THE WINDOW IN THE SCALE.

TWO PRECAUTIONS ARE NECESSARY IN THE OPERATION OF THE POINT (STATION) ADVANCE CONTROL. THESE ARE: (1) THE PRINT MOTOR SHOULD BE TURNED OFF, AND (2) THE CONTROL SHOULD BE TURNED ONLY IN THE DIRECTION OF THE ARROW INDICATED ON THE SCALE.

IF THE PRINT FREQUENCY IS QUITE SLOW, SMALL POINT (STATION) ADVANCES MAY BE MADE BETWEEN PRINT-OUTS WITHOUT TURNING OFF THE PRINT MOTOR. HOWEVER, PRINT-OUTS THAT ARE MADE WHILE THE POINT (STATION) NUMBER IS BEING ADVANCED IN THIS MANNER ARE OF DOUBTFUL ACCURACY.

IF AN ACCURATE FIRST PRINT-OUT IS DESIRED OF A CERTAIN POINT (STATION), PROCEED AS FOLLOWS:

(1) TURN PRINT MOTOR OFF.

(2) ADVANCE THE CONTROL TO THE POINT (STATION) NUMBER PRECEDING THE DESIRED POINT (STATION) NUMBER. FOR EXAMPLE: IF ACCURATE FIRST PRINTOUT IS DESIRED ON POINT (STATION) 1, SET THE ADVANCE CONTROL TO POINT (STATION) 24.

(3) THEN TURN ON PRINT MOTOR. AS PER EXAMPLE, POINT (STATION) 24 MAY OR MAY NOT PRINT, BUT THE PRINT-OUT OF POINT (STATION) 1 WILL BE ACCURATE.

PUTTING INSTRUMENT IN OPERATION

(1) MAKE POWER INPUT CONNECTIONS AS DESCRIBED UNDER "POWER AND ACCESSORY CONNECTIONS" IN THIS SECTION.

(2) OBSERVE CORRECT POLARITY AND CONNECT ALL SIGNAL SOURCES TO THE MULTIPLE-SIGNAL INPUT PANEL (TB501). REFER TO "SIGNAL INPUT CONNECTIONS" AS DESCRIBED IN THIS SECTION.

(3) CHECK FOR INSTALLATION OF THE PROPER RANGE CARD(S).

(4) IF THE SIGNAL INPUT PANEL IS WIRED FOR A SELECTABLE NUMBER-OF-POINTS, SEE THAT THE CORRECT NUMBER-OF-POINTS (-STATIONS) SOCKET IS INSERTED ON THE INPUT PANEL (TB501). THE PRINT WHEEL AND THE POINT (STATION) INDICATOR WHEEL SHOULD AGREE WITH THE NUMBER-OF-POINT (STATION) SELECTION.

(5) CHECK AMPLIFIER PLUG AND SOCKET FOR SECURE CONNECTION.

(6) SEE THAT THE CORRECT CHART IS PROPERLY INSTALLED. REFER TO "CHART DRIVE INSTRUCTIONS" (PART 2).

(7) TURN ON POWER SWITCH. IF MAXIMUM ACCURACY IS DESIRED AT BEGINNING OF RECORDING, ALLOW INSTRUMENT TO WARM UP FOR 30 MINUTES FOR STABILIZATION OF INTERNAL TEMPERATURE.

(8) TO INK THE PRINT WHEEL, TURN THE MANUAL POINT (STATION) ADVANCE CONTROL ONE OR TWO REVOLUTIONS IN THE DIRECTION INDICATED BY THE ARROW ON THE SCALE.

(9) Use manual chart advance and set chart to correct time if provided with time markings. Set time line to highest point on chart-drive roll.

(10) Turn on print motor switch and CHART DRIVE switch. Input selector switching, printing, and servo action should now begin.

Printing Check: The characters printed out on the chart should be clearly perceptible. Too light a print-out, partial images of adjacent points at print-out, or a blurred print-out may indicate that the printhead impact spring is incorrectly adjusted. Images of adjacent points at print-out may also indicate that the print wheel is not mechanically synchronized. To insure that the print wheel is mechanically synchronized, check to see that the scribe mark located on the print wheel hub is in line with the pin in the tapered retaining sleeve.

CAUTION: If the printing is too light or blurred, allow the instrument to print out about 30 times so that print wheel may become properly inked. In this manner, a faint printing will often darken or a blurred printing will often clear up so that an adjustment of the printhead impact spring becomes unnecessary. However, if an adjustment is required, refer to the "Mechanical Maintenance" section in SECTION III of PART 3 for the mechanical adjustment procedures.

A blurred print-out may also indicate a dirty print wheel. The print wheel should be kept free of dirt and lint at all times. A soft-bristled brush may be used periodically to keep the type characters of the print wheel clean. If excessive dirt and dried ink accumulate on the print wheel, the wheel should be removed and thoroughly washed in a mild soap solution.

CAUTION: When washing the print wheel, be careful not to damage the type characters. Also, when re-installing the print wheel, make sure that the scribe mark on the print wheel hub lines up with the pin in the tapered retaining sleeve. This procedure retains the mechanical synchronization of the print wheel with the point selection of the selector switch.

After cleaning and installing the print wheel, re-ink the wheel by manually turning the point (station) advance control several revolutions in the direction indicated by the arrow on the scale.

A light or faded print-out after a prolonged period of operation usually indicates that the unicolor or multicolor ink pads are drying out and need to be replaced. Refer to the "Mechanical Maintenance" section in SECTION III of PART 3 for procedures on replacing a unicolor pad or a multicolor ink wheel.

Print-Out Sequence: If the recorder is operating with a number-of-point (-station) selection which is evenly divisible into 24--such as 2, 3, 4, 6, 8, 12, or 24--the designated number-of-points are sequentially printed out for each complete revolution of the selector switch. For example, take the case of a 4-point selection. In this particular application, the print-out of points 1 through 4 will be repeated six times during the complete revolution of the selector switch. The same type of reasoning may be applied to a 2-, 3-, 6-, 8-, 12-, or 24-point selection. However, if the recorder is operating with a 10-, 16-, 18-, or 20-point selection (not evenly divisible into

TABLE 3.1. PRINT-OUT SEQUENCE OF NUMBER-OF-POINTS NOT EVENLY DIVISIBLE INTO 24.

NUMBER-OF-POINTS (-STATIONS)	RECORDING SEQUENCE PER CYCLE
10	1 Thru 10, 5 and 6 Repeated, 1 Thru 10 Repeated, 5 and 6 Repeated
16	1 Thur 16, 5 Thru 12 Repeated
18	1 Thru 18, 7 Thru 12 Repeated
20	1 Thru 20, 9 Thru 12 Repeated

TABLE 3.2. OPERATING SEQUENCE OF MULTICOLOR PRINT-OUT.

2-POINT SELECTION		3-POINT SELECTION		4-POINT SELECTION		6-POINT SELECTION		8-POINT SELECTION		10-POINT SELECTION*	
POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR
1	RED	1	RED	1	RED	1	RED	1	RED	1	RED
2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN
1	RED	3	BLUE	3	BLUE	3	BLUE	3	BLUE	3	BLUE
2	GREEN	1	RED	4	BLACK	4	BLACK	4	BLACK	4	BLACK
1	RED	2	GREEN	1	RED	5	PURPLE	5	RED	5	PURPLE
2	GREEN	3	BLUE	2	GREEN	6	BROWN	6	GREEN	6	BROWN
1	RED	1	RED	3	BLUE	1	RED	7	BLUE	7	RED
2	GREEN	2	GREEN	4	BLACK	2	GREEN	8	BLACK	8	GREEN
1	RED	3	BLUE	1	RED	3	BLUE	1	RED	9	BLUE
ETC.		ETC.		ETC.		ETC.		ETC.		ETC.	

12-POINT SELECTION		16-POINT SELECTION*		18-POINT SELECTION*		20-POINT SELECTION*		24-POINT SELECTION	
POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR
1	RED	1	RED	1	RED	1	RED	1	RED
2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN
3	BLUE	3	BLUE	3	BLUE	3	BLUE	3	BLUE
4	BLACK	4	BLACK	4	BLACK	4	BLACK	4	BLACK
5	PURPLE	5	PURPLE	5	PURPLE	5	PURPLE	5	PURPLE
6	BROWN	6	BROWN	6	BROWN	6	BROWN	6	BROWN
7	RED	7	RED	7	RED	7	RED	7	RED
8	GREEN	8	GREEN	8	GREEN	8	GREEN	8	GREEN
9	BLUE	9	BLUE	9	BLUE	9	BLUE	9	BLUE
ETC.		ETC.		ETC.		ETC.		ETC.	

*SEE TABLE 3.1 FOR PRINT-OUT SEQUENCE.

TABLE 3.3. RECOMMENDED MINIMUM CHART SPEEDS FOR CLEAR PRINT-OUT WITH DIFFERENT INPUT SIGNAL VALUES.

PRINT FREQUENCY (SECONDS/POINT)	NUMBER-OF-POINTS										
	2	3	4	6	8	10	12	16	18	20	24
	CHART SPEED (INCHES-PER-HOUR)										
1	240	96	80	48	40	24	24	20	20	12	12
1.5	120	60	60	30	24	15	15	12	12	8	8
3	60	30	24	15	12	8	8	6	6	4	4
6	24	16	12	8	6	4	4	3	2	2	1.5
7.5	15	10	8	6	4	3	3	2	2	1.5	1.5
12	12	8	6	4	3	2	1.5	1.5	1.5	1	1
15	8	6	4	3	2	1.5	1	1	1	1	1
24	6	4	3	1.5	1.5	1	1	1	1	1	1
30	4	3	1.5	1	1	1	1	1	1	1	1
60	2	1.5	1	1	1	1	1	1	1	1	1
120	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
150	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5

NOTE: To Avoid Overprinting, If Two or More Points Have Same Value, Divide 225 by Print Frequency in Seconds and Select the Next Fastest Chart Speed.

24), the print-out sequence for each complete revolution of the selector switch is shown in Table 3.1.

If the recorder is equipped with a multicolor ink wheel, each point or group of points will be printed out in a specific color on the chart. The maximum number of different colors available is six. Refer to Table 3.2 for the standard colors used and the print-out sequence of the various point (station) selections.

CAUTION: When re-installing a multicolor ink wheel after a cleaning procedure, make sure that it is properly aligned to the print wheel. This mechanical alignment ensures the proper synchronization of colors for the various number-of-points (-stations) selected. See "Replacing Multicolor Ink Wheel" under ROUTINE MAINTENANCE instructions. A unicolor ink wheel needs no alignment since the same color is printed for all points.

Recommended Minimum Chart Speeds: The chart speeds recommended in Table 3.3 will normally result in a graphic record where each printing impression has cleared the previous impression. It shows in inches-per-hour the optimum chart speeds for different number-of-points (-stations) with respect to the various optional print frequencies. Refer to the instrument DATA SHEET for number-of-points, print frequency, and available chart speeds.

OPERATOR CONTROL ADJUSTMENT PROCEDURES

The following procedures pertain to the adjustment of the GAIN, THRESHOLD, and DAMPING controls.

NOTE: All adjustments are made with a portable potentiometer being used as the source of the test signals (see Figure 3.12). The values of the test signals should be reproducible within 0.1% accuracy.

(1) Turn off POWER, CHART DRIVE, and print motor switches on recorder.

(2) Remove the negative (-) signal input lead from terminal 2 of the

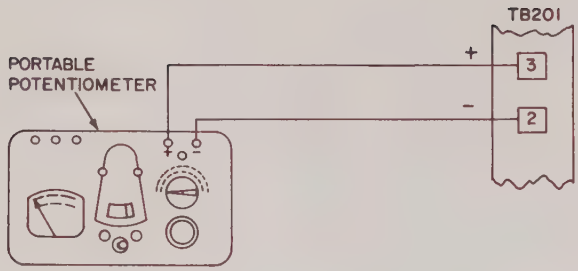


FIGURE 3.12. TEST SIGNAL CONNECTION DIAGRAM.

AMPLIFIER TERMINAL BLOCK (TB201).

(3) CONNECT THE POSITIVE (+) AND NEGATIVE (-) LEADS OF PORTABLE POTENTIOMETER TO TERMINALS 3 (+) AND 2 (-) OF TB201 AS SHOWN IN FIGURE 3.12.

(4) TURN DAMPING CONTROL TO MIDRANGE.

NOTE: SINCE STOPS OF CONTROL MAY NOT BE DEFINITELY FELT OR HEARD (AUDIBLE CLICKING SOUND), TURN CONTROL AT LEAST 25 TURNS IN EITHER DIRECTION. THEN BACK OFF ABOUT 13 TURNS.

(5) TURN GAIN CONTROL FULLY CLOCKWISE.

NOTE: SINCE STOPS OF CONTROL MAY NOT BE DEFINITELY FELT OR HEARD (AUDIBLE CLICKING SOUND), TURN CONTROL AT LEAST 25 TURNS.

(6) ADJUST THRESHOLD CONTROL TO OBTAIN A "DEADBAND TEST" THAT DOES NOT EXCEED 0.1% OF SPAN.

DEADBAND TEST:

(A) DISENGAGE SWITCH ACTUATING PAWL FROM SELECTOR SWITCH RATCHET AND SECURE PAWL IN DISENGAGED POSITION.

(B) TURN ON POWER SWITCH AND ALLOW 10-MINUTE WARM-UP PERIOD; THEN, TURN ON CHART DRIVE SWITCH.

(C) DETERMINE THE INPUT SPAN OF THE MEASURING RANGE (SEE INSTRUMENT DATA SHEET).

NOTE: IN TEMPERATURE MEASURING INSTRUMENTS, REFER TO THERMOCOUPLE TEMPERATURE-EMF CONVERSION TABLES TO DETERMINE THE EQUIVALENT MILLIVOLTAGE SPAN FOR A PARTICULAR THERMOCOUPLE-ACTUATED MEASURING RANGE. THE TYPE OF SIGNAL INPUT ACTUATION, TYPE OF THERMOCOUPLE (IF INPUT IS THERMOCOUPLE-ACTUATED), AND MEASURING RANGE OF YOUR RECORDER ARE SPECIFIED ON THE INSTRUMENT DATA SHEET.

(D) AFTER DETERMINING MEASURING SPAN OF INSTRUMENT, TURN ON PRINT MOTOR SWITCH AND APPLY AN INPUT SIGNAL THAT PRINTS OUT A POINT AT 50% OF SPAN ON THE CHART. OBSERVE INPUT VALUE SET ON PORTABLE POTENTIOMETER.

(E) INCREASE INPUT SIGNAL FROM POTENTIOMETER SO THAT PRINT-OUT OF POINT IS INCREASED BY APPROXIMATELY 1% OF SPAN ABOVE THE 50% VALUE ON THE CHART. CAREFULLY RESET POTENTIOMETER TO 50% SIGNAL VALUE (DO NOT UNDERSHOOT) OBSERVED IN STEP (D) ABOVE.

(F) DECREASE INPUT SIGNAL FROM POTENTIOMETER SO THAT PRINT-OUT OF POINT IS DECREASED BY APPROXIMATELY 1% OF SPAN BELOW THE 50% VALUE ON THE CHART. CAREFULLY RESET POTENTIOMETER TO 50% SIGNAL VALUE (DO NOT OVERSHOOT) OBSERVED IN STEP (D) ABOVE.

(G) OBSERVE RECORDED PRINT-OUTS ON THE CHART AT THE 50% VALUE. DEADBAND SHOULD NOT EXCEED 0.1% OF SPAN. MAKE SURE CHART SPEED IS FAST ENOUGH TO PROPERLY EVALUATE THE DEADBAND TEST.

(H) REPEAT PROCEDURES OF DEADBAND TEST UNTIL CLEAR INDICATIVE RESULTS ARE OBTAINED.

NOTE: DURING THE DEADBAND TESTING, IT MAY BE NOTICED THAT AFTER SEVERAL PRINT-OUTS (USUALLY ABOUT 3 OR 4) OF THE SAME POINT (STATION), THE RECORDED DOT WILL BECOME FAINT OR MAY DISAPPEAR ENTIRELY DUE TO LACK OF INK ON THE PRINT WHEEL FOR THAT PARTICULAR POINT (STATION). IN THIS CASE, RE-INK THE PRINT WHEEL BY TURNING POINT (STATION) ADVANCE CONTROL TWO OR THREE REVOLUTIONS IN THE COUNTERCLOCKWISE DIRECTION. THEN CONTINUE WITH THE DEADBAND TESTING BY USING ANY POINT SELECTED ON THE PRINT WHEEL.

(7) If necessary, make re-adjustments of THRESHOLD control and repeat making "Deadband Test" until deadband does not exceed 0.1% of span.

(8) Turn GAIN control to a position in the most counterclockwise direction that still maintains a "Deadband Test" within 0.1% of span.

(9) Apply a 90% of span input signal in a step function (input signal cycled on and off); and check to see that overshoot, as observed by the pointer overshoot on the scale, does not exceed 5% of span.

NOTE: The midrange adjustment of the DAMPING control, as set forth in Step 4 above, normally provides a damping adjustment well within the 5%-of-span tolerance; therefore, no further adjustment of the GAIN or THRESHOLD control is necessary. However, if overshoot is not within tolerance, readjust DAMPING control to provide an overshoot that does not exceed 5% of span. Then proceed to Step 10.

(10) Readjust either GAIN or THRESHOLD control (as specified below) to obtain a "Deadband Test" that does not exceed 0.1% of span.

(A) THRESHOLD--If input span of measuring range is 1MV.

(B) GAIN--If input span of measuring range is greater than 1MV.

(11) Remove portable potentiometer leads from terminals 3 and 2 of TB201. Reconnect the negative (-) signal input lead to terminal 2 of TB201.

OPTIONAL FEATURES

Operating instructions for optional accessories and for special recorder modifications are contained in the APPENDIX, PART 6. Refer to the instrument DATA SHEET to determine optional features incorporated into a particular recorder.

SECTION III MAINTENANCE

This section of the manual pertains to the maintenance procedures for the electro-mechanical servo measuring system and the electro-mechanical printing/input selection system employed in the Model E1124E Multipoint Recorder. Maintenance procedures for the chart drive are contained in PART 2 of this manual.

The measuring and printing systems of the multipoint have been designed and built for long trouble-free service. Nevertheless, the instrument should receive the care afforded any precision piece of equipment to maintain optimum performance and to extend its useful life. Contact your nearest Esterline Angus authorized representative when special factory service is desired. If troubleshooting or other service becomes necessary in the field, refer to the maintenance procedures outlined in this section.

WARNING: To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

The MAINTENANCE section (SECTION III) is further subdivided into two major sections--the MECHANICAL MAINTENANCE section and the ELECTRICAL MAINTENANCE section.

The MECHANICAL MAINTENANCE section contains information applicable to the servicing procedures of components which govern the mechanical operation of the servo measuring system and the printing/input selection system.

The ELECTRICAL MAINTENANCE section contains information applicable to the servicing procedures of components which deal with the electrical operation of the servo measuring system.

The content of information covered in each of these sections is listed as follows:

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Mechanical Maintenance

ROUTINE MAINTENANCE

Periodic maintenance schedules should be established and followed to insure trouble-free operation. These schedules should include inspection, cleaning, lubrication, print wheel replacement, and re-inking procedures. Because of wide variation in environmental conditions and frequency of use, no fixed time intervals are recommended for the routine maintenance procedures. Therefore, maintenance scheduling is left entirely up to the discretion of the user. Where extreme temperatures or contaminated atmospheres prevail, the user should adopt a more frequent schedule.

INSPECTION

A complete visual inspection of the print-mechanism gear train and the printhead transport system should be made at each routine maintenance period in order to locate the possible malfunctioning of components which may impair the operation of the recorder. Checks on the following should be made:

(1) All gearing, shafts, linkages, leaf switches (in gearbox), selector switch contacts, and other associated components in the gear-train drive should be free from an accumulation of dirt or other foreign particles.

(2) Loose, missing, binding, damaged, or worn components.

(3) Mechanical misalignment of components (see MECHANICAL SERVICE ADJUSTMENTS).

(4) Proper drive cable tension (see "Drive Cable Replacement").

(5) Dirty or worn print wheel.

(6) Dirty or dried-out ink pads.

(7) Proper adjustment of the printhead impact spring (see MECHANICAL SERVICE ADJUSTMENTS).

If any fault is discovered by the inspection procedures listed above, corrective maintenance should be performed without delay.

CLEANING

Regardless of the precautions taken, dirt and dust will enter the recorder case; therefore, periodic cleaning of the exposed components within the recorder case will be required.

Cleaning of the print-mechanism gear train and other interior components may be maintained with a soft-bristled brush, a lint-free cloth, and a suitable solvent.

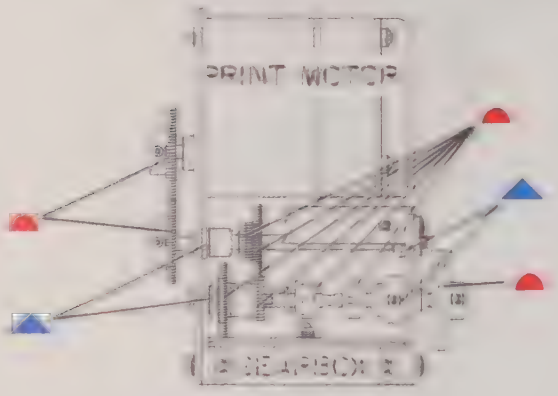
Dirt lodged in lubricant may be removed by a brush and a mild solvent. Ink stains left on metal surfaces may also be removed with a cloth dampened in a mild solvent. Harsh solvents should not be used because of possible damage to components which are molded out of plastic. When cleaning with a solvent, always allow parts to thoroughly dry before applying any lubricant. Also, do not allow solvent to drip on the chart drive components or onto the periphery of other surrounding parts.

Large exposed surfaces of the main frame and the surfaces of the case enclosure may be cleaned by using a soft-bristled brush and/or a low-vacuum cleaner. A cloth dampened with a mild soap solution may also be used to clean dirt-affected areas of the main frame and the case enclosure.

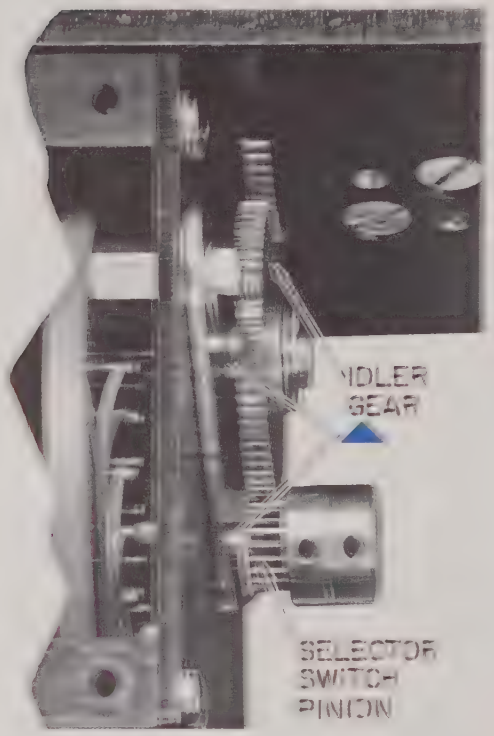
CAUTION: Do not disturb mechanical alignment of parts or routing of wiring during the cleaning procedures.

Ink Wheel: For unicolor printing, replace dirty or dried-out pad on ink wheel. For multicolor printing, replace dirty or dried-out pads by installing a new multicolor ink wheel assembly. No attempt should be made to clean the pad(s). Refer to "Re-Inking Procedures" for pad and/or wheel replacement procedures. If the periphery of the ink wheel needs cleaning, the wheel should be removed and cleaned with a cloth dampened in alcohol.

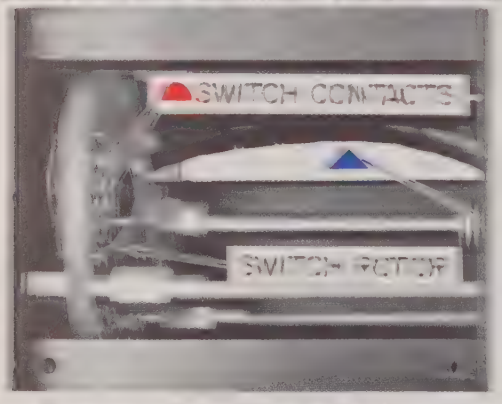
PRINT MOTOR AND GEARBOX



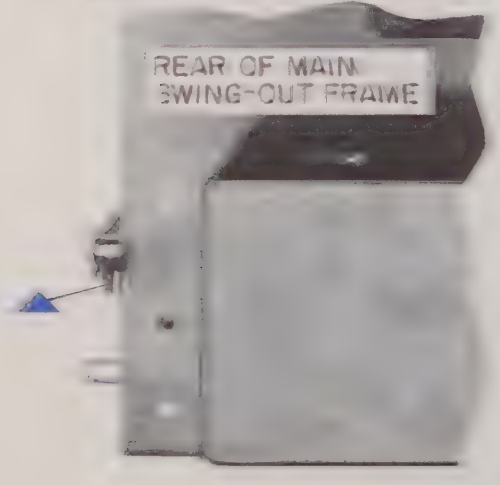
BEARING SURFACES



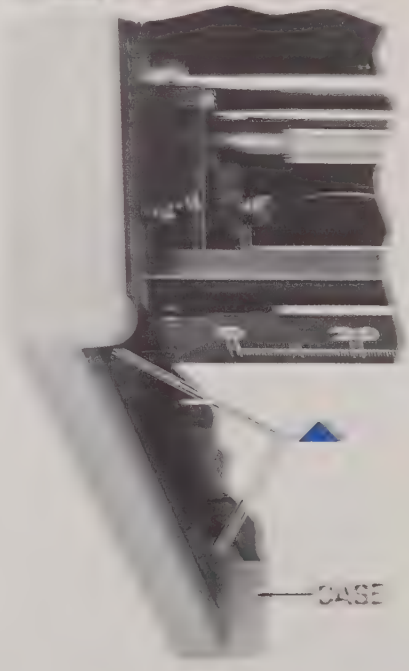
SELECTOR SWITCH ASSEMBLY



MAIN FRAME LATCH



MAIN FRAME HINGE



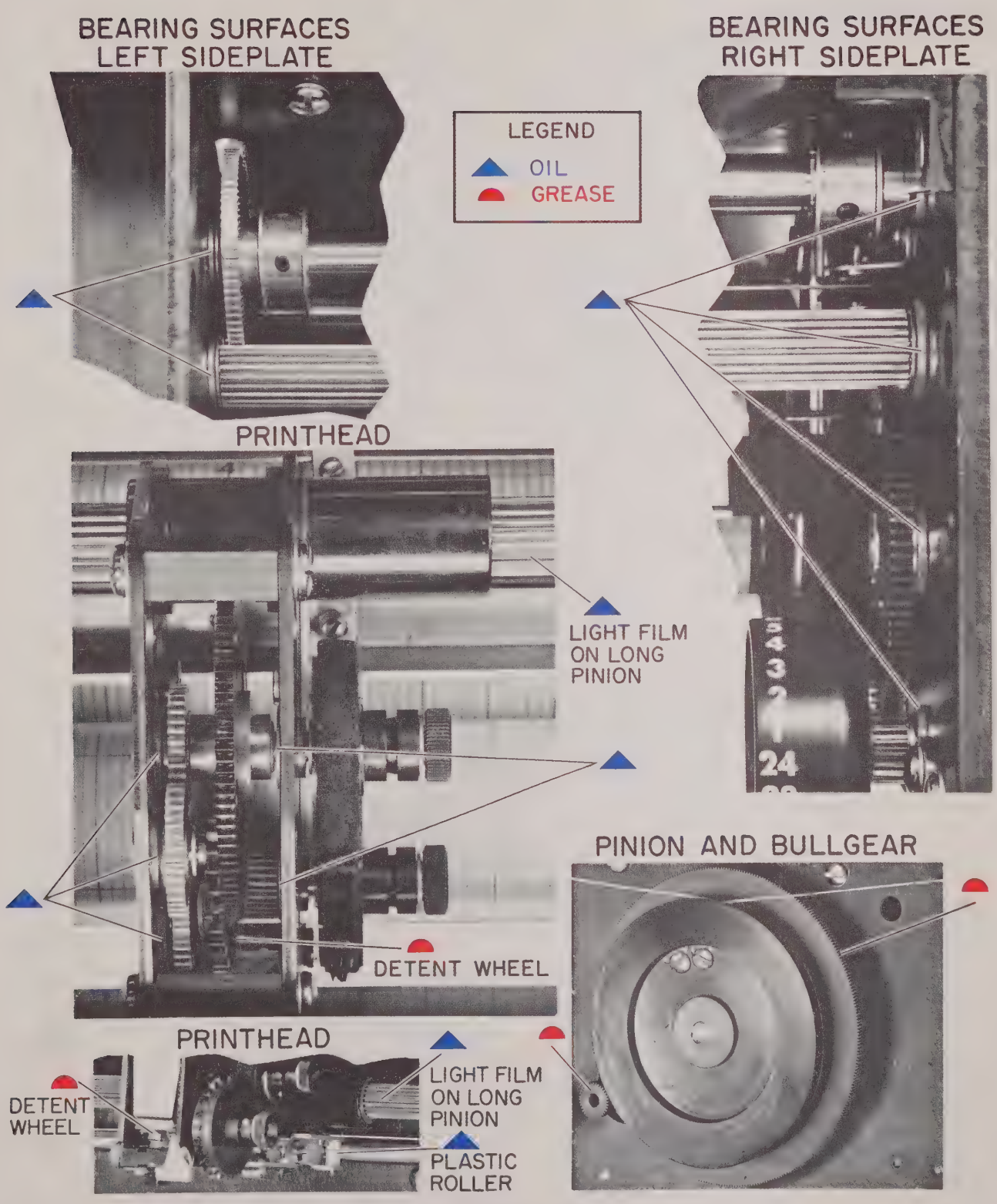


FIGURE 3.13B. LUBRICATION POINTS.

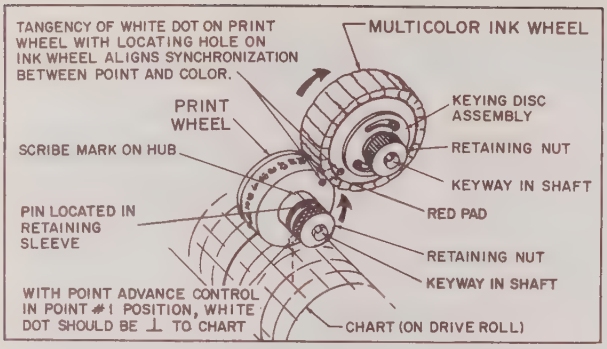

TANGENCY OF WHITE DOT ON PRINT WHEEL WITH LOCATING HOLE ON INK WHEEL ALIGNS SYNCHRONIZATION BETWEEN POINT AND COLOR.
MULTICOLOR INK WHEEL
PRINT WHEEL
KEYING DISC ASSEMBLY
SCRIBE MARK ON HUB
RETAINING NUT
KEYWAY IN SHAFT
PIN LOCATED IN RETAINING SLEEVE
RED PAD
RETAINING NUT
KEYWAY IN SHAFT
WITH POINT ADVANCE CONTROL IN POINT #1 POSITION, WHITE DOT SHOULD BE ⊥ TO CHART
CHART (ON DRIVE ROLL)

FIGURE 3.14. PRINT WHEEL AND INK WHEEL ALIGNMENT.

CAUTION: WHEN A MULTICOLOR INK WHEEL IS REINSTALLED ON ITS SHAFT AFTER CLEANING, MAKE SURE THAT IT IS ALIGNED WITH THE PRINT WHEEL SO THAT THE PROPER COLOR VERSES POINT SYNCHRONIZATION IS MAINTAINED (SEE FIGURE 3.14). NO ALIGNMENT PROCEDURES ARE REQUIRED FOR UNICOLOR PRINTING SINCE THE SAME COLOR IS PRINTED FOR ALL POINTS.

PRINT WHEEL: THE PRINT WHEEL SHOULD BE PERIODICALLY CLEANED WITH A SOFT-BRISTLED BRUSH. IF A LAYER OF DIRT AND DRIED INK ACCUMULATE ON THE PRINT WHEEL, REMOVE THE WHEEL AND WASH IT IN A MILD SOAP SOLUTION.

CAUTION: WHEN WASHING THE PRINT WHEEL, CARE SHOULD BE TAKEN NOT TO DAMAGE THE TYPE CHARACTERS. WHEN RE-INSTALLING THE PRINT WHEEL, MAKE SURE AND ALIGN THE SCRIBE MARK ON THE PRINT WHEEL HUB WITH THE PIN IN THE TAPERED RETAINING SLEEVE (SEE FIGURE 3.14). THIS RELATIONSHIP RETAINS THE MECHANICAL SYNCHRONIZATION OF THE PRINT WHEEL WITH THE POINT SELECTION OF THE SELECTOR SWITCH.

AFTER CLEANING AND INSTALLING THE PRINT WHEEL, RE-INK THE WHEEL BY MANUALLY TURNING THE POINT (STATION) ADVANCE CONTROL SEVERAL REVOLUTIONS IN THE DIRECTION INDICATED BY THE ARROW ON THE SCALE.

LUBRICATION

BECAUSE OF WIDE VARIATION IN ENVIRONMENTAL CONDITIONS AND MANNER OF OPERATION, NO FIXED TIME SCHEDULE CAN BE PRESCRIBED FOR THE LUBRICATION OF THE OVERALL PRINT-MECHANISM GEAR TRAIN DRIVE. THE OILITE BEARINGS NORMALLY HOLD ENOUGH OIL FOR SEVERAL MONTHS OF CONTINUOUS OPERATION; HOWEVER, THIS OIL IS WASHED AWAY TO SOME EXTENT BY CLEANING SOLVENTS AND MUST BE REPLENISHED. WHERE THE DIRT PROBLEM IS NEGLIGIBLE, LUBRICANT MUST STILL BE RENEWED FROM TIME TO TIME. OTHER POINTS CAN BE EXPECTED TO REQUIRE LUBRICATION MORE FREQUENTLY, ESPECIALLY FRICTION POINTS AND SURFACES INVOLVED IN THE MOVEMENTS OF THE PRINTHEAD.

THE RECOMMENDED LUBRICANTS ARE SUPPLIED IN A KIT AVAILABLE FROM ESTERLINE ANGUS. THE COMPLETE KIT AND THE INDIVIDUAL LUBRICANTS WHICH COMPRISE THE KIT ARE IDENTIFIED BY PART NUMBERS FOUND IN PART 5, ACCESSORIES AND SUPPLIES. OTHER LUBRICANTS WHICH MAY BE USED AS EQUIVALENTS TO THE ONES SUPPLIED IN THE KIT ARE AS FOLLOWS:

LUBRICATING OIL:

STANOIL 35 (MANUFACTURED BY STANDARD OIL DIVISION OF AMERICAN OIL COMPANY).

GULF HARMONY 53 (MANUFACTURED BY GULF OIL COMPANY).

LUBRICATING GREASE (FOR GEAR TEETH):

BEACON 325 (MANUFACTURED BY HUMBLE OIL AND REFINING COMPANY).

LUBRICATING GREASE (FOR SWITCH CONTACTS):

ANY SILICONE-TYPE GREASE.

PRECAUTIONS ON LUBRICATION

(1) ALWAYS CLEAN THE PART OR ASSEMBLY BEFORE LUBRICATING.

(2) IF SOLVENTS ARE USED IN THE CLEANING PROCESS, ALLOW CLEANED AREAS TO THOROUGHLY DRY BEFORE LUBRICATING.

(3) DO NOT OVER-LUBRICATE. ALWAYS WIPE OFF EXCESS LUBRICANT BEFORE EXPOSING THE INSTRUMENT TO A DIRT-LADEN ATMOSPHERE.

LUBRICATION POINTS (REFER TO FIGURE 3.13)

BALANCING (SERVO) MOTOR AND SLIDE-WIRE: THE BALANCING MOTOR AND SLIDE-WIRE POTENTIOMETER ARE PERMANENTLY LUBRICATED AND REQUIRE NO LUBRICATION MAINTENANCE.

PRINT MOTOR: THE PRINT MOTOR IS OF THE PERMANENTLY-LUBRICATED TYPE AND REQUIRES NO LUBRICATION MAINTENANCE.

INPUT SELECTOR SWITCH CONTACTS: IF THE INSTRUMENT IS OPERATED APPROXIMATELY 40 HOURS PER WEEK, IT IS RECOMMENDED THAT THE INPUT-POINT SELECTOR SWITCH CONTACTS BE LUBRICATED EVERY SIX MONTHS WITH INSTRUMENT GREASE (E.A. #01599, OR EQUIVALENT).

GEAR TEETH: THE INTERMEDIATE DRIVE GEARS BETWEEN THE PRINT MOTOR AND THE INSTRUMENT GEARBOX, THE GEARS IN THE GEARBOX (ALSO GEARBOX OUTPUT CAM), THE DETENT WHEEL AT THE FRONT OF THE PRINTHEAD, THE BALANCING (SERVO) MOTOR PINION, AND THE BULLGEAR SHOULD BE LUBRICATED WITH INSTRUMENT GREASE (E.A. #407751, OR EQUIVALENT).

CAUTION: IT IS RECOMMENDED THAT GREASE NOT BE APPLIED TO THE LONG PINION SUPPORTING THE PRINTHEAD (POINT OR STATION ADVANCE PINION) OR TO ANY GEAR THAT MIGHT DIRECTLY OR INDIRECTLY TRANSFER GREASE TO THE LONG PINION. THIS PRECAUTION APPLIES PARTICULARLY TO THE GEARS IN THE PRINTHEAD. THE LONG PINION SHOULD BE FREQUENTLY CHECKED FOR HAVING AN ADEQUATE FILM OF OIL, BUT IT SHOULD NEVER BE DRIPPING WITH OIL. A CLOTH DAMPENED WITH OIL AND LIGHTLY RUBBED OVER THE PINION AT REQUIRED INTERVALS WILL PROVIDE SUFFICIENT LUBRICATION.

PRINTHEAD PLASTIC ROLLER: THE PLASTIC ROLLER AT THE REAR OF THE PRINTHEAD SHOULD BE LIGHTLY OILED.

OILITE BEARINGS: BEARING SURFACES SHOULD BE LIGHTLY OILED.

MAIN FRAME HINGE AND LATCH: A DROP OR TWO OF OIL SHOULD ALSO BE PERIODICALLY APPLIED TO THE UPPER AND LOWER PIVOT POINTS OF THE MAIN FRAME HINGE AND TO THE MAIN FRAME LATCH.

PRINT WHEEL REPLACEMENT

AFTER PROLONGED USE THE TYPE CHARACTERS ON THE PRINT WHEEL WILL EVENTUALLY WEAR DOWN, THUS NECESSITATING A REPLACEMENT OF THE PRINT WHEEL. THE PART NUMBER OF THE FACTORY-INSTALLED PRINT WHEEL IS LISTED ON THE INSTRUMENT DATA SHEET. PART NUMBERS FOR THE VARIOUS PRINT WHEEL ASSEMBLIES ARE LISTED IN THE ILLUSTRATED PARTS BREAKDOWN, SECTION II OF PART 4.

THE REPLACEMENT WHEEL SHOULD BE INSTALLED AND MECHANICALLY ALIGNED AS FOLLOWS:

(1) LOOSEN THE KNURLED NUT WITH THE FINGERS AND REMOVE NUT AND LOCKWASHER FROM SHAFT.

(2) REMOVE TAPERED RETAINING SLEEVE AND REMOVE OLD PRINT WHEEL FROM SHAFT. CLEAN SHAFT IF NECESSARY.

(3) INSTALL REPLACEMENT PRINT WHEEL ON SHAFT AND REPLACE THE TAPERED RETAINING SLEEVE. DO NOT SNUG-FIT THE SLEEVE AGAINST THE PRINT WHEEL SO THAT THE WHEEL CAN BE FREELY TURNED ON ITS SHAFT.

(4) TURN THE POINT (STATION) ADVANCE CONTROL IN THE COUNTERCLOCKWISE DIRECTION UNTIL A NUMBER 1 ON THE POINT (STATION) INDICATOR WHEEL APPEARS THROUGH THE WINDOW ON THE SCALE.

NOTE: NUMBERING SEQUENCE ON INDICATOR WHEEL SHOULD ALWAYS BE IDENTICAL TO NUMBERING SEQUENCE ON PRINT WHEEL.

(5) HOLD INK WHEEL STATIONARY AND MANUALLY TURN PRINT WHEEL SO THAT WHITE DOT ON SIDE OF PRINT WHEEL FACES DIRECTLY DOWNWARD AND PERPENDICULAR TO THE CHART. THE WHITE DOT SERVES TO EASILY LOCATE POINT #1 POSITION ON THE PRINT WHEEL. SEE FIGURE 3.14.

(6) NOW SNUG THE TAPERED RETAINING SLEEVE AGAINST THE PRINT WHEEL AND INSTALL LOCKWASHER AND KNURLED NUT ON SHAFT. FINGER-TIGHTEN THE NUT.

(7) TO INK THE PRINT WHEEL, TURN THE POINT (STATION) ADVANCE CONTROL TWO OR THREE REVOLUTIONS IN THE COUNTERCLOCKWISE DIRECTION.

(8) TURN ON THE INSTRUMENT AND ALLOW PRINTING OF AT LEAST 6 OR 7 POINTS. USE VARYING LEVELS OF SIGNAL INPUT (OR MANUALLY POSITION PRINTHEAD AT DIFFERENT LATERAL POSITIONS) SO THAT PRINTING DOES NOT OCCUR AT THE SAME PLACE ON THE CHART.

(9) OBSERVE PRINTING ON CHART. THE POINT (OR STATION) NUMBERS ON THE PRINT WHEEL SHOULD TRACK IN SEQUENCE WITH THE NUMBERS ON THE POINT (STATION) INDICATOR WHEEL. THE ENTIRE TYPE CHARACTER OF EACH SELECTED NUMBER SHOULD BE PRINTED WITHOUT ANY PARTIAL PRINTING FROM ADJACENT TYPE CHARACTERS ON THE PRINT WHEEL.

(10) If proper printing results are not obtained, turn off instrument. Loosen the retaining nut and back off the tapered retaining sleeve. Slightly reposition the print wheel in the required direction, retighten retaining nut, and recheck printing. Repeat Steps 8, 9, and 10 until proper printing results are obtained.

(11) After proper alignment between the print wheel and point (station) indicator wheel is obtained, scribe a mark on the print wheel hub in line with the center of the pin in the tapered retaining sleeve (see Figure 3.14). This mark provides a mechanical referencing point and is used as a quick method of re-aligning the print wheel whenever it is removed and re-installed.

(12) If the printing is either too light or too heavy, adjust the tension of the printhead impact spring as described under the MECHANICAL SERVICE ADJUSTMENTS instructions.

RE-INKING PROCEDURES

If the recorder has not been operated for a period of time, it will often print faintly when operation is first resumed. The instrument should therefore be permitted to operate for several minutes to see if the printing will darken. In most cases the printing will darken, thus avoiding a premature replacement of the ink pad (or ink wheel) and/or a needless adjustment of the printhead impact spring. However, if ink pad (or ink wheel) replacement is necessary, refer to the procedures which follow.

Unicolor Re-Inking Procedures: The unicolor ink wheel assembly consists of a molded plastic flange and hub, a circular inking pad, and a removable metal flange. The inking pad is installed between the two flanges.

The ink wheel assembly is retained on its shaft between an "E" ring on one end and a lockwasher and knurled nut on the other end. The nut should only be finger-tightened.

NOTE: For unicolor printing, a spare unicolor ink-pad kit is furnished with the recorder. The kit includes two unicolor ink pads, which are of the same color as the original factory-installed ink pad. Part numbers for the various unicolor ink-pad kits and ink wheel assemblies are found in PART 5, ACCESSORIES AND SUPPLIES. The factory-installed ink wheel assembly is identified by a part number on the instrument DATA SHEET. It is recommended that two spare ink pads always be kept on hand.

To change the ink pad, proceed as follows:

(1) Loosen the knurled nut with the fingers and remove nut and lockwasher from shaft.

(2) Remove ink wheel assembly from shaft.

(3) Remove metal flange and remove old pad. Clean shaft, plastic wheel, and metal flange with a mild solvent if necessary.

(4) Install new pad in place on plastic wheel, replace flange, and place ink wheel assembly on shaft.

(5) Replace lockwasher and knurled nut on shaft. Finger-tighten the nut.

(6) To ink the print wheel, turn the point (station) advance control two or three revolutions in the counter-clockwise direction.

(7) Turn on instrument and check for satisfactory printing. If the printing is either too light or too heavy, adjust the tension of the printhead impact spring as described under the MECHANICAL SERVICE ADJUSTMENTS instructions.

NOTE: If it is preferred to replace the entire ink wheel assembly as a unit, remove old ink wheel assembly as stated in Steps 1 and 2 above; clean shaft if necessary. Then install new ink wheel assembly on shaft and perform Steps 5, 6, and 7 above.

TABLE 3.4. STANDARD COLOR SEQUENCE OF POINT SELECTION EVENLY DIVISIBLE INTO 24.

SECTOR NO. OF INK WHEEL	2-POINT SELECTION		3-POINT SELECTION		4-POINT SELECTION		6-POINT SELECTION		8-POINT SELECTION		12-POINT SELECTION		24-POINT SELECTION	
	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR
1	1	RED	1	RED	1	RED	1	RED	1	RED	1	RED	1	RED
2	2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN	2	GREEN
3	1	RED	3	BLUE	3	BLUE	3	BLUE	3	BLUE	3	BLUE	3	BLUE
4	2	GREEN	1	RED	4	BLACK	4	BLACK	4	BLACK	4	BLACK	4	BLACK
5	1	RED	2	GREEN	1	RED	5	PURPLE	5	RED	5	PURPLE	5	PURPLE
6	2	GREEN	3	BLUE	2	GREEN	6	BROWN	6	GREEN	6	BROWN	6	BROWN
7	1	RED	1	RED	3	BLUE	1	RED	7	BLUE	7	RED	7	RED
8	2	GREEN	2	GREEN	4	BLACK	2	GREEN	8	BLACK	8	GREEN	8	GREEN
9	1	RED	3	BLUE	1	RED	3	BLUE	1	RED	9	BLUE	9	BLUE
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
ETC. THRU 24	ABOVE COLOR SEQUENCES ARE REPEATED THRU THE 24 SECTORS OF THE INK WHEEL.													

MULTICOLOR RE-INKING PROCEDURES: THE MULTICOLOR INK WHEEL ASSEMBLY CONSISTS OF A MOLDED PLASTIC WHEEL HAVING 24 RADIALLY ARRANGED SECTORS FOR THE 24 INK PADS, AND AN INTEGRALLY-MOUNTED METAL FLANGE WHICH HAS A LOCATING HOLE AND PIN FABRICATED INTO IT. THE LOCATING PIN AND HOLE ARE MECHANICALLY ASSOCIATED WITH A KEYING DISC ASSEMBLY FOR PROPERLY ALIGNING THE INK WHEEL TO THE PRINT WHEEL SO THAT SYNCHRONIZATION BETWEEN POINT AND COLOR IS ESTABLISHED (SEE TABLES 3.4 AND 3.5).

THE INK WHEEL ASSEMBLY IS RETAINED ON ITS SHAFT BETWEEN AN "E" RING ON ONE END AND THE KEYING DISC, LOCKWASHER, AND KNURLED NUT ON THE OTHER END.

THE DIFFERENT NUMBER OF COLORS AVAILABLE IN THE INK WHEEL IS: TWO, THREE, FOUR, OR SIX. THE STANDARD COLOR SEQUENCE AS INSTALLED AT THE FACTORY IS: RED, GREEN, BLUE, BLACK, PURPLE, AND BROWN. THIS SAME COLOR SEQUENCE IS FOLLOWED IF THE NUMBER OF COLORS USED IS LESS THAN SIX, BUT THE PATTERN REPEATS ITSELF EARLIER IN THE SEQUENCE AS SHOWN IN TABLE 3.4.

THE MULTICOLOR PRINTING SYSTEM IS RE-INKED BY INSTALLING THE ENTIRE INK WHEEL ASSEMBLY AS A UNIT.

NOTE: A SPARE MULTICOLOR INK WHEEL IDENTICAL TO THE FACTORY-INSTALLED WHEEL IS FURNISHED WITH THE RECORDER. THE FACTORY-INSTALLED INK WHEEL IS IDENTIFIED BY A PART NUMBER ON THE INSTRUMENT DATA SHEET. IT IS RECOMMENDED THAT A SPARE INK WHEEL BE KEPT ON HAND AT ALL TIMES. PART NUMBERS FOR THE VARIOUS MULTICOLOR INK WHEEL ASSEMBLIES ARE LISTED IN PART 5, ACCESSORIES AND SUPPLIES.

REPLACING MULTICOLOR INK WHEEL: INSTALL NEW WHEEL AS FOLLOWS:

(1) LOOSEN KNURLED NUT WITH FINGERS, AND REMOVE NUT AND LOCKWASHER FROM SHAFT.

(2) NOTE POSITION OF PARTS, AND THEN REMOVE DISC ASSEMBLY AND INK WHEEL FROM SHAFT.

CAUTION: DO NOT LOOSEN OR REMOVE THE 2 SMALL SCREWS IN THE DISC ASSEMBLY.

(3) CLEAN SHAFT IF NECESSARY.

(4) Install new ink wheel assembly and original disc assembly on shaft. Key disc assembly to shaft and rotate wheel until locating pin on wheel engages notch in rim of inner disc.

(5) Install lockwasher and knurled nut on shaft. Finger tighten knurled nut.

(6) To ink print wheel, turn point (station) advance control two or three revolutions in the counterclockwise direction.

(7) Turn on instrument and allow printing of at least 6 or 7 points. Use varying levels of signal input (or manually position the printhead at different lateral positions) so that printing does not occur at the same place on the chart.

(8) If printing is either too light or too heavy, adjust tension of printhead impact spring as described under the MECHANICAL SERVICE ADJUSTMENTS instructions.

CAUTION: If both the multicolor ink wheel and the print wheel are replaced at the same time, first make sure that the print wheel is mechanically synchronized with the point (station) indicator wheel before installing the ink wheel. Refer to topic heading "Print Wheel Replacement" for mechanical alignment instructions of print wheel.

TABLE 3.5. STANDARD COLOR SEQUENCE OF POINT SELECTION NOT EVENLY DIVISIBLE INTO 24.

SECTOR NO. OF INK WHEEL	10-POINT SELECTION*		16-POINT SELECTION*		18-POINT SELECTION*		20-POINT SELECTION*	
	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR	POINT NO.	COLOR
1	1	Red	1	Red	1	Red	1	Red
2	2	Green	2	Green	2	Green	2	Green
3	3	Blue	3	Blue	3	Blue	3	Blue
4	4	Black	4	Black	4	Black	4	Black
5	5	Purple	5	Purple	5	Purple	5	Purple
6	6	Brown	6	Brown	6	Brown	6	Brown
7	7	Red	7	Red	7	Red	7	Red
8	8	Green	8	Green	8	Green	8	Green
9	9	Blue	9	Blue	9	Blue	9	Blue
10	10	Black	10	Black	10	Black	10	Black
11	5	Purple	11	Purple	11	Purple	11	Purple
12	6	Brown	12	Brown	12	Brown	12	Brown
13	1	Red	13	Red	13	Red	13	Red
14	2	Green	14	Green	14	Green	14	Green
15	3	Blue	15	Blue	15	Blue	15	Blue
16	4	Black	16	Black	16	Black	16	Black
17	5	Purple	5	Purple	17	Purple	17	Purple
18	6	Brown	6	Brown	18	Brown	18	Brown
17	7	Red	7	Red	7	Red	19	Red
20	8	Green	8	Green	8	Green	20	Green
21	9	Blue	9	Blue	9	Blue	9	Blue
22	10	Black	10	Black	10	Black	10	Black
23	5	Purple	11	Purple	11	Purple	11	Purple
24	6	Brown	12	Brown	12	Brown	12	Brown

*Refer to Table 3.6.

TABLE 3.6. PRINTING SEQUENCE OF POINT SELECTION NOT EVENLY DIVISIBLE INTO 24.

NUMBER-OF-POINTS (-STATIONS)	RECORDING SEQUENCE PER CYCLE OF SELECTOR SWITCH
10	1 THRU 10, 5 AND 6 REPEATED, 1 THRU 10 REPEATED, 5 AND 6 REPEATED
16	1 THRU 16, 5 THRU 12 REPEATED
18	1 THRU 18, 7 THRU 12 REPEATED
20	1 THRU 20, 9 THRU 12 REPEATED

DRIVE CABLE REPLACEMENT

THE DRIVE CABLE IS MADE OF WOVEN STAINLESS STEEL WIRE AND IS COATED WITH NYLON. CARE SHOULD BE TAKEN IN HANDLING THE CABLE SO THAT IT IS NOT KINKED OR BRUISED.

To Remove Cable: TO REMOVE THE OLD CABLE, FIRST SWING OUT THE CHART FRAME. LOOSEN THE TWO CLAMPING SCREWS ON THE CABLE DRIVE PULLEY AND THE TWO CABLE CLAMPING SCREWS ON THE PRINTHEAD. NOW REMOVE THE OLD CABLE.

To Install Cable: TO INSTALL THE NEW CABLE, MANUALLY TURN THE CABLE DRIVE PULLEY TO ITS MAXIMUM CLOCKWISE POSITION (AGAINST OVERTRAVEL MECHANICAL STOP).

REFER TO FIGURE 3.15 AND FOLLOW DRIVE CABLE STRINGING. DURING THE STRINGING PROCEDURE, LEAVE DRIVE CABLE UNCLAMPED FROM PRINTHEAD BRACKET.

To Test Cable Tension: AFTER THE CABLE HAS BEEN STRUNG, CHECK FOR PROPER TENSION AS FOLLOWS:

(1) LEAVE CABLE UNCLAMPED FROM PRINTHEAD BRACKET.

(2) SUSPEND AN 85-GRAM WEIGHT FROM THE CENTER POINT OF THE TOP STRETCH OF CABLE. THE CABLE SHOULD SAG ABOUT 1/4" FROM ITS HORIZONTAL POSITION (SEE FIGURE 3.15). IF TENSION IS INCORRECT, LOOSEN ONE OF THE CLAMPING SCREWS ON THE CABLE DRIVE PULLEY AND TIGHTEN OR LOOSEN CABLE UNTIL PROPER TENSION IS OBTAINED. RETIGHTEN CLAMPING SCREW.

(3) MANUALLY TURN THE CABLE DRIVE PULLEY CLOCKWISE AND COUNTERCLOCKWISE BETWEEN ITS MECHANICAL STOPS AND CHECK TO SEE THAT DRIVE CABLE MOVES FREELY AND SMOOTHLY. AFTER PROPER OPERATION IS ENSURED, CUT OFF EXCESS LENGTH OF CABLE AT THE CLAMPING SCREWS.

Clamping Printhead to Drive Cable:

NOTE: THE FOLLOWING PROCEDURES ARE BASED ON THE ASSUMPTION THAT THE MECHANICAL CALIBRATION OF THE INSTRUMENT WAS KNOWN TO BE ACCURATE BEFORE THE DRIVE CABLE REPLACEMENT. IF THE MECHANICAL CALIBRATION WAS KNOWN TO BE INACCURATE BEFORE CABLE REPLACEMENT, OR IF IT IS DESIRED TO CHECK THE ACCURACY OF THE MECHANICAL CALIBRATION, LEAVE PRINTHEAD UNCLAMPED AT THIS TIME AND PERFORM THE PROCEDURES OUTLINED UNDER TOPIC HEADING "MECHANICAL CALIBRATION ADJUSTMENTS" IN THE MECHANICAL SERVICE ADJUSTMENTS INSTRUCTIONS. THE MECHANICAL CALIBRATION ADJUSTMENTS SHOULD ALWAYS FIRST BE CHECKED BEFORE PERFORMING THE ELECTRICAL CALIBRATION ADJUSTMENTS. THE ELECTRICAL CALIBRATION ADJUSTMENTS ARE OUTLINED UNDER TOPIC HEADING "MILLIVOLT CALIBRATION PROCEDURES" IN THE ELECTRICAL MAINTENANCE SECTION.

CLAMP THE PRINTHEAD TO THE DRIVE CABLE AS FOLLOWS:

(1) MANUALLY TURN THE CABLE DRIVE PULLEY IN THE CLOCKWISE DIRECTION UNTIL THE OVERTRAVEL MECHANICAL STOP IS REACHED.

(2) HOLD DRIVE PULLEY STATIONARY AND SLIDE PRINTHEAD ALONG PINION UNTIL POINTER IS ALIGNED WITH 0% MARKING OF SCALE. NOW CLAMP THE DRIVE CABLE TO THE PRINTHEAD BY TIGHTENING THE TWO CABLE CLAMPING SCREWS.

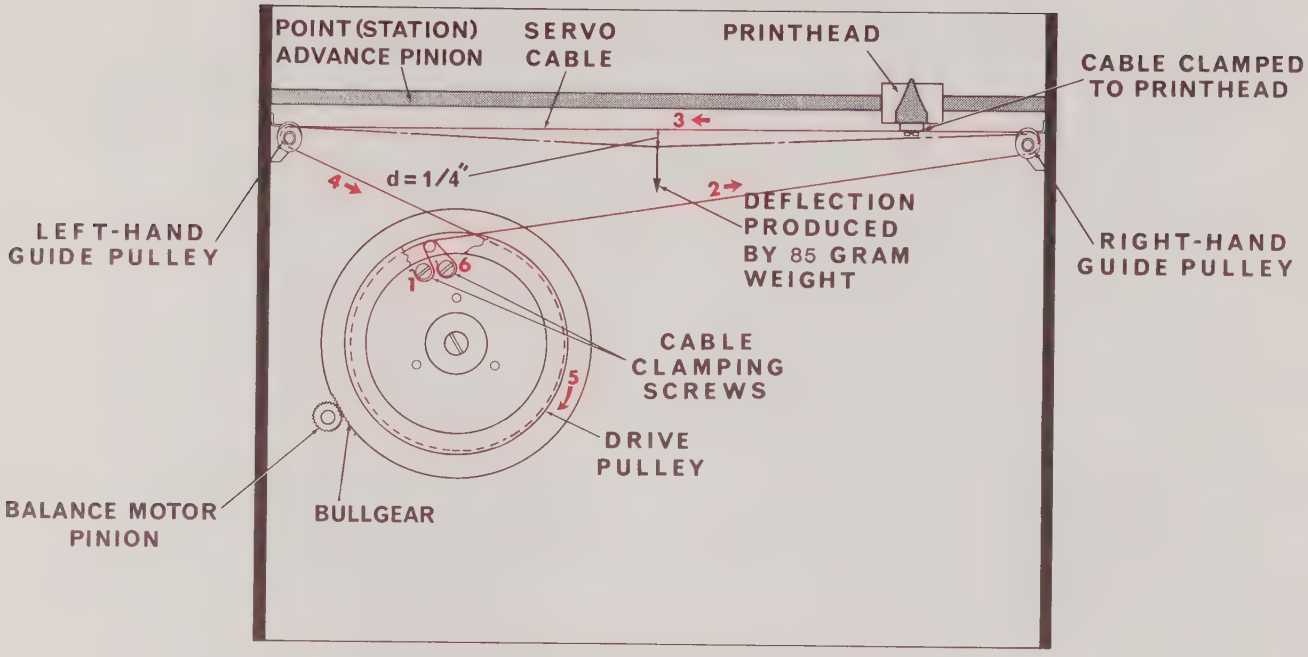


FIGURE 3.15. DRIVE CABLE STRINGING.

NOTE: PAGES 3-45 AND 3-46 ARE DELETED. NEXT PAGE IS 3-47.

SHUTDOWN PROCEDURE

The multipoint recorder may be taken out of service for indefinite periods of time without any definite shutdown procedure. However, it is recommended that the ink wheel be removed from the printhead and wrapped airtight in a cellophane or plastic bag to prevent ink evaporation from pad(s).

If the recorder is to transported over any long distance, the swing-out mechanisms should be secured within the recorder case by re-installing the bolts in the shipping blocks. The recorder should be packed in the same manner as when received from the factory.

Upon resuming operation, remove all securements and packing materials (if used). Check to see that mechanism parts are clean and lubricated (see ROUTINE MAINTENANCE instructions). Re-install the ink wheel. If a multicolor ink wheel is being used, make sure that it is properly aligned to the print wheel. This mechanical alignment assures the proper synchronization of colors for the various number-of-points (-stations) selected. See "Replacing Multicolor Ink Wheel" under ROUTINE MAINTENANCE instructions. No keying is provided on a unicolor ink wheel for alignment purposes since the same color is printed for all points (stations).

Resume operation as described under subject entitled "PUTTING INSTRUMENT IN OPERATION" in SECTION II (Operation) of PART 3.

MECHANICAL TROUBLESHOOTING

The following troubleshooting guide in Table 3.7 is useful in isolating the more common troubles which may affect the mechanical transport of the printhead and/or the mechanical operations involved in the printing and input selection mechanism.

It should be noted that a particular trouble symptom may be caused by either an electrical or a mechanical fault, or possibly by both electrical and mechanical faults.

Trouble symptoms affecting the electrical operation of the servo measuring system are listed in the "Electrical Troubleshooting Guide" in the ELECTRICAL MAINTENANCE section. Mechanical maintenance procedures on the chart drive may be found in PART 2, SECTION III of this manual.

TABLE 3.7. MECHANICAL TROUBLESHOOTING GUIDE.

SYMPTOM	POSSIBLE CAUSE	REMEDY
(1) Balance (servo) motor operates, but servo gear train (pinion and bullgear) is not driven.	Pinion loose on motor shaft. (See Figure 3.15).	Center mesh of pinion to bullgear and tighten set screw in pinion.

TABLE 3.7 MECHANICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(2) Servo gear train (pinion and bullgear) drives normally, but no lateral response of printhead.	Loose, derailed, or broken drive cable.	Check drive cable stringing instructions as described under "Drive Cable Replacement."
	Printhead loose on drive cable.	Refer to "Mechanical Calibration Adjustments" and clamp printhead to drive cable at proper point.
(3) Servo gear train (pinion and bullgear) drives normally, but printhead will not travel full-scale extreme.	Printhead improperly positioned on drive cable.	Position printhead on drive cable as outlined under "Mechanical Calibration Adjustments."
(4) Printhead responds sluggishly. Abnormally slow response time.	Servo gear train (pinion and bullgear) binding. (See Figure 3.15).	Center mesh of pinion to bullgear and adjust position of servo motor for minimum backlash with no binding.
	Incorrect tension of drive cable.	Refer to tension adjustment procedures under "Drive Cable Replacement."
	Dirty and/or unlubricated mechanism.	Refer to "Cleaning" and "Lubrication" instructions under ROUTINE MAINTENANCE.
(5) Values recorded on the chart and/or indicated on the scale are consistently high or low for all known input signals.	Printhead improperly positioned on drive cable.	Refer to instructions outlined under "Mechanical Calibration Adjustments."
	Scale improperly positioned.	
(6) Smudged printing.	Signal cutoff switch always open.	Adjust proximity of leaf switch segments so that contacts close when actuated by the cam.
	Signal cutoff switch incorrectly timed.	Refer to "Signal Cutoff Switch Adjustment" procedure (Item C) under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(7) Blurred printing.	Dirty print wheel.	Refer to "Cleaning" instructions under ROUTINE MAINTENANCE.
	Printhead impact spring improperly adjusted.	See instructions outlined under "Printhead Impact Spring Adjustment."

TABLE 3.7. MECHANICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(8) Partial image of an adjacent point (station) number on print wheel is printed.	Print wheel incorrectly aligned.	Align scribe mark on print wheel hub with center line of pin in tapered retaining sleeve (see Figure 3.14). Retighten retaining nut. NOTE: If above procedure does not remedy the fault, follow instructions in Item D under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
	Insufficient tension of printhead detent spring.	Loosen two screws at the top (front end) of the printhead. Press detent spring inward so that peak bottoms into one of the notches on detent wheel. Retighten screws.
	Printing and input selection mechanism improperly adjusted.	Refer to adjustment procedure Items A and B (Steps 1 through 17) under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(9) Weak or no printing at all places along the chart.	Lack of ink.	See "Re-Inking Procedures" under ROUTINE MAINTENANCE instructions.
	Printhead impact spring improperly adjusted.	See instructions outlined under "Printhead Impact Spring Adjustment."
	Printing and input selection mechanism improperly adjusted.	Refer to adjustment procedure Items A and B under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(10) No indexing of print wheel, but point (station) indicator wheel indexes normally.	Loose detent spring in printhead.	Loosen two screws at the top (front end) of the printhead. Press detent spring inward so that peak bottoms into one of the notches on detent wheel. Retighten screws.
	Loose print wheel.	Align scribe mark on print wheel hub with

(Cont'd. Next Page)

TABLE 3.7. MECHANICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(CONTINUED)		CENTER LINE OF PIN IN TAPERED RETAINING SLEEVE (SEE FIGURE 3.14). TIGHTEN RETAINING NUT.
(11) BOTH PRINT WHEEL AND POINT (STATION) INDICATOR WHEEL DO NOT INDEX. PRINTING MOTION OF PRINTHEAD NORMAL AND SELECTOR SWITCH ADVANCES.	LOOSE SWITCH OUTPUT PINION.	ALIGN AND TIGHTEN PINION; FOLLOW ADJUSTMENT PROCEDURE ITEM B, STEP 17 UNDER SERVICE ADJUSTMENT SUBJECT ENTITLED "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM."
(12) SAME AS SYMPTOM 11 BUT SELECTOR SWITCH ALSO DOES NOT ADVANCE.	MECHANICAL BINDING OF SWITCH ACTUATING PAWL, LOOSE SELECTOR SWITCH RATCHET, OR LOOSE PAWL ARM. (SEE FIGURE 3.18).	LOCATE AND REMOVE BIND OR OBSTRUCTION.
		TIGHTEN SELECTOR SWITCH RATCHET.
		ALIGN AND TIGHTEN PAWL ARM; FOLLOW ADJUSTMENT PROCEDURE ITEMS A AND B (STEPS 1 THROUGH 8) UNDER SERVICE ADJUSTMENT SUBJECT ENTITLED "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM."
(13) GEARBOX OUTPUT CAM TURNS NORMALLY, BUT NO PRINTING MOTION OF PRINTHEAD AND NO INDEXING OF THE PRINT WHEEL AND POINT (STATION) INDICATOR WHEEL.	LOOSE CAM FOLLOWER (PRINTHEAD REMAINS IN THE PRINTING POSITION).	ALIGN AND TIGHTEN CAM FOLLOWER. FOLLOW ADJUSTMENT PROCEDURE ITEMS A AND B (STEPS 1 THROUGH 8) UNDER SERVICE ADJUSTMENT SUBJECT ENTITLED "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM."
	MECHANICAL BINDING OF COMPONENTS.	LOCATE AND REMOVE BIND OR OBSTRUCTION.
(14) POINT (STATION) NUMBER PRINTED ON CHART DOES NOT AGREE WITH POINT (STATION) SELECTION OF SELECTOR SWITCH.	PRINT WHEEL IMPROPERLY SYNCHRONIZED WITH POINT SELECTION OF SELECTOR SWITCH.	ALIGN PRINT WHEEL; FOLLOW ADJUSTMENT PROCEDURE ITEM D UNDER SERVICE ADJUSTMENT SUBJECT ENTITLED "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM."
(15) POINT (STATION) INDICATOR WHEEL DOES NOT AGREE WITH POINT NUMBER PRINTED ON CHART.	INDICATOR WHEEL IMPROPERLY INSTALLED.	FIRST MAKE SURE THAT PRINT WHEEL IS SYNCHRONIZED WITH POINT SELECTION OF SELECTOR SWITCH (SEE SYMPTOM 14). THEN ALIGN INDICATOR WHEEL SO THAT NUMBER APPEARING THROUGH WINDOW IN SCALE AGREES WITH THE NUMBER PRINTED ON THE CHART.

TABLE 3.7. MECHANICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(16) Light or no printing on left side of chart.	Printhead actuating shaft not parallel to the point (station) advance pinion.	Follow adjustment procedure Items A and B (Steps 1 through 8) under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
	Printhead height misadjusted.	Follow adjustment procedure Item B, Steps 14 and 15 under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(17) Printing okay on left side, but light or no printing on right side of chart.	Latching between main mechanism frame and chart drive frame misadjusted.	Refer to instructions outlined under "Frame Adjustments." Follow adjustment procedure Item B, Step 16 under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(18) In a multicolor printing system, points (stations) are not printed out in the standard color sequence shown in Tables 3.4 and 3.5.	Multicolor ink wheel incorrectly aligned.	Check installation of ink wheel to see that it is properly aligned with print wheel. See "Replacing Multicolor Ink Wheel" under ROUTINE MAINTENANCE instructions. NOTE: If above procedure does not remedy the fault, follow instructions in Item E under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
(19) Printed record of measured values shows evidence that adjacent signal inputs on input panel are being paralleled.	Rotor associated with signal switch deck in selector switch assembly misadjusted.	Follow adjustment procedure Item B, Steps 9 through 13 under service adjustment subject entitled "Adjustments of the Printing and Input Selection Mechanism."
	Incorrect connections of sensing elements.	Check sensing element connections.

TABLE 3.7. MECHANICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(20) PRINTED NUMBERS ARE PRINTING ON TOP OF EACH OTHER.	CHART SPEED NOT COMPATIBLE (TOO SLOW) WITH PRINT FREQUENCY.	INCREASE THE CHART SPEED. REFER TO TABLE 3.3 IN SECTION II (OPERATION) OF PART 3 FOR THE RECOMMENDED MINIMUM CHART SPEEDS.

MECHANICAL SERVICE ADJUSTMENTS

PRINTHEAD IMPACT SPRING ADJUSTMENT

THE PRINTHEAD IMPACT SPRING WILL NORMALLY NEED A RE-ADJUSTMENT WHENEVER THE PRINT WHEEL AND/OR INK WHEEL (OR INK PADS ONLY) ARE REPLACED. RE-ADJUSTMENT MAY ALSO BE NECESSARY DURING THE COURSE OF NORMAL OPERATION AS THE INK PAD(S) BEGINS TO "WEAR IN." RE-ADJUSTMENT REQUIREMENTS ARE USUALLY INDICATED WHEN PRINTING BECOMES TOO DARK (BLURRED) OR TOO LIGHT (FADED). PROPER ADJUSTMENT OF THE IMPACT SPRING IS OBTAINED WHEN THE PRINTING APPEARS CLEAR AND DISTINCT.

NOTE: BEFORE CHANGING THE ADJUSTMENT OF THE PRINTHEAD IMPACT SPRING, MAKE SURE THAT THE PRINT WHEEL HAS BEEN PROPERLY INKED. MANUALLY TURN THE POINT (STATION) ADVANCE CONTROL TWO OR THREE REVOLUTIONS IN THE COUNTERCLOCKWISE DIRECTION. THEN ALLOW THE INSTRUMENT TO AUTOMATICALLY PRINT OUT ABOUT 30 TIMES. IF PRINTING IS NOT CLEAR AND DISTINCT, ADJUST IMPACT SPRING FOR PROPER TENSION.

REFER TO FIGURE 3.16 AND ADJUST IMPACT SPRING AS FOLLOWS:

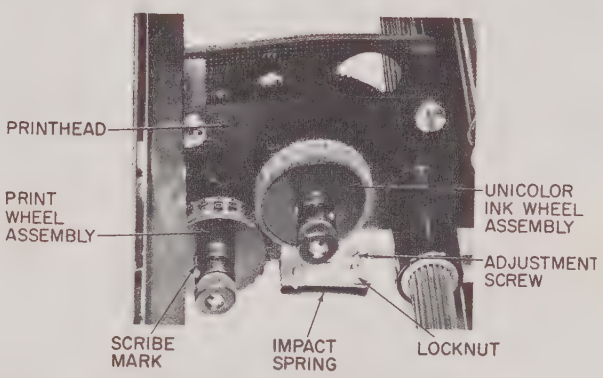


FIGURE 3.16. PRINTHEAD IMPACT SPRING ADJUSTMENT.

PRINTING TOO LIGHT (FADED)

(1) HOLD ADJUSTMENT SCREW IN PLACE WITH SCREWDRIVER AND LOOSEN LOCKNUT WITH 3/16" OPEN-END WRENCH.

(2) TURN SCREW COUNTERCLOCKWISE (INCREASES IMPACT PRESSURE) IN 1/4-TURN INCREMENTS FOR EACH ADJUSTMENT. HOLD ADJUSTMENT OF SCREW IN PLACE WITH SCREWDRIVER, RETIGHTEN LOCKNUT, AND CHECK PRINTING. REPEAT STEPS 1 AND 2 UNTIL CLEAR AND DISTINCT PRINTING RESULTS ARE OBTAINED.

PRINTING TOO HEAVY (BLURRED)

(1) HOLD ADJUSTMENT SCREW IN PLACE WITH SCREWDRIVER AND LOOSEN LOCKNUT WITH 3/16" OPEN-END WRENCH.

(2) TURN SCREW CLOCKWISE (DECREASES IMPACT PRESSURE) IN 1/4-TURN INCREMENTS FOR EACH ADJUSTMENT. HOLD ADJUSTMENT OF SCREW IN PLACE, WITH SCREWDRIVER, RETIGHTEN LOCKNUT, AND CHECK PRINTING. REPEAT STEPS 1 AND 2 UNTIL CLEAR AND DISTINCT PRINTING RESULTS ARE OBTAINED.

MECHANICAL CALIBRATION ADJUSTMENTS

THE MECHANICAL CALIBRATION OF THE INSTRUMENT HAS BEEN CAREFULLY PERFORMED AT THE FACTORY AND SHOULD NOT REQUIRE FURTHER ATTENTION IN THE FIELD. HOWEVER, IF CORRECTIVE MAINTENANCE OR A RANGE CHANGE (NEW SCALE REQUIRED) HAS BEEN MADE, THE MECHANICAL CALIBRATION SHOULD BE CHECKED AND PROPER ADJUSTMENTS MADE (IF NECESSARY) BEFORE ANY OF THE ELECTRICAL CALIBRATION ADJUSTMENTS ARE MADE. THE ELECTRICAL CALIBRATION ADJUSTMENTS ARE COVERED UNDER TOPIC HEADING "RECORDER CALIBRATION" IN THE ELECTRICAL MAINTENANCE SECTION. CHECK THE MECHANICAL CALIBRATION IN THE FOLLOWING SEQUENCE:

(1) Alignment of Chart Paper: Check to see that perforations in the chart paper are centered on the pins in the chart drive roll. Refer to charting instructions in PART 2, SECTION II (Operation) in this manual.

(2) Aligning Printhead to the Chart and to the Overtravel Mechanical Stop

CAUTION: If no overrunning clutches are used in the gearbox and if print motor speed is 4RPM, it will be necessary to disengage one of the external intermediate-drive gears at the input side of the gearbox so that the printing operation can be manually actuated in compliance with the instructions that follow.

To Check Alignment

(A) Manually displace printhead to low end of scale until the overtravel mechanical stop is reached. Leave printhead at this position and then manually turn the gearbox output cam in a counterclockwise direction to allow a print-out on the chart. Continue to turn gearbox output cam after print-out so that printhead attains its normal upper-rest position. Observe printing on chart. The dot should print directly on or slightly below (within 1/16") the 0% line of chart.

(B) Now move printhead to high end of scale until the overtravel mechanical stop is reached again. Leave printhead in this position and again manually turn the gearbox output cam in a counterclockwise direction to allow a print-out on the chart. Continue to turn gearbox output cam after print-out so that printhead attains its normal upper-rest position. Observe printing on chart. The dot should print directly on or slightly above (within 1/16") the 100% line of chart.

(C) If the printhead does not print at the correct position at either or both ends of the chart, correct as follows:

To Correct Alignment

(A) Loosen cable clamping screws on printhead bracket and position printhead at low end of the scale. Turn the gearbox output cam to allow printing operation and check to see where dot is printed on the chart. Reposition printhead as necessary and repeat printing operation until dot is printed approximately 1/16" below 0% line of chart. Leave printhead in printing position.

(B) Manually turn the cable drive pulley in the clockwise direction until the overtravel mechanical stop is reached. Hold cable drive pulley at this position and clamp drive cable to the printhead by tightening the two cable clampling screws.

(C) With printhead now clamped to the drive cable, run printhead to high end of scale until the overtravel mechanical stop is reached again. Leave printhead at this position and turn gearbox output cam to allow printing operation. The dot should be printed directly on or slightly above (within 1/16") 100% line of chart.

(D) If print-out is below 100% line of chart, or in excess of 1/16" above 100% line of chart, proceed as follows:

(E) Refer to Figure 3.16-1 and disassemble the servo gear-train components. Loosen two screws in the overtravel stop bracket and adjust bracket as follows:

(F) If the print-out in Step (C) is below the 100% line of chart, slightly move bracket outward (away from the slidewire hub and gear assembly). If the printout in Step (C) is in excess of 1/16" above 100% line of chart, slightly move bracket inward (toward the slidewire hub and gear assembly).

(G) After overtravel stop bracket adjustment is made, retighten the two screws that secure the stop bracket. Reassemble the servo gear-train components in the sequence shown in Figure 3.16-1. Repeat Steps (A) through (F) above until printhead overtravel at each end of the chart does not exceed 1/16" below 0% line of chart or 1/16" above 100% line of chart, as established by the limits of the overtravel mechanical stop.

(3) Aligning Scale to the Pointer

(A) Loosen the two scale-mounting screws.

(B) Manually displace printhead downscale until overtravel mechanical stop is reached. Position scale so that 0% marking on scale is in line with the end of the pointer. Retighten the two scale-mounting screws.

After completing mechanical calibration adjustments, make final and precise electrical calibration adjustments as covered under topic heading "Recorder Calibration" in the ELECTRICAL MAINTENANCE section.

SLIP-CLUTCH ADJUSTMENT

Refer to Figure 3.16-1 and proceed as follows:

Checking Clutch Operation

(A) Unlatch chart drive frame from main mechanism frame, and swing out chart frame.

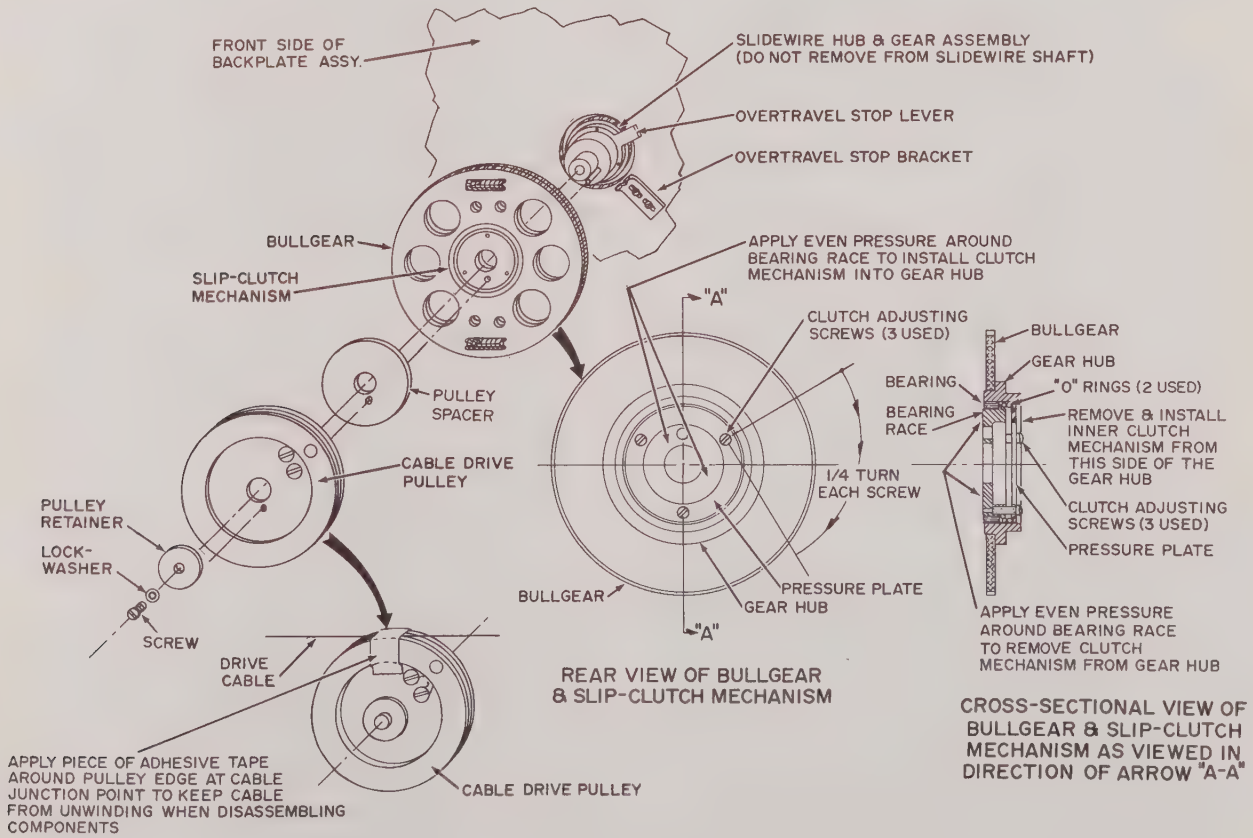

FRONT SIDE OF BACKPLATE ASSY.
SLIDEWIRE HUB & GEAR ASSEMBLY (DO NOT REMOVE FROM SLIDEWIRE SHAFT)
OVERTRAVEL STOP LEVER
OVERTRAVEL STOP BRACKET
BULLGEAR
SLIP-CLUTCH MECHANISM
APPLY EVEN PRESSURE AROUND BEARING RACE TO INSTALL CLUTCH MECHANISM INTO GEAR HUB
"A"
CLUTCH ADJUSTING SCREWS (3 USED)
PULLEY SPACER
CABLE DRIVE PULLEY
1/4 TURN EACH SCREW
PULLEY RETAINER
LOCK-WASHER
SCREW
DRIVE CABLE
BULLGEAR
PRESSURE PLATE
GEAR HUB
"A"
REAR VIEW OF BULLGEAR & SLIP-CLUTCH MECHANISM
BULLGEAR
GEAR HUB
BEARING
"O" RINGS (2 USED)
BEARING RACE
REMOVE & INSTALL INNER CLUTCH MECHANISM FROM THIS SIDE OF THE GEAR HUB
CLUTCH ADJUSTING SCREWS (3 USED)
PRESSURE PLATE
APPLY EVEN PRESSURE AROUND BEARING RACE TO REMOVE CLUTCH MECHANISM FROM GEAR HUB
CROSS-SECTIONAL VIEW OF BULLGEAR & SLIP-CLUTCH MECHANISM AS VIEWED IN DIRECTION OF ARROW "A-A"
APPLY PIECE OF ADHESIVE TAPE AROUND PULLEY EDGE AT CABLE JUNCTION POINT TO KEEP CABLE FROM UNWINDING WHEN DISASSEMBLING COMPONENTS
CABLE DRIVE PULLEY

FIGURE 3.16-1. DISASSEMBLY AND ADJUSTMENT OF SERVO-GEAR-TRAIN COMPONENTS.

(B) Grasp bullgear (not cable drive pulley) and manually rotate bullgear in either direction. As bullgear is being rotated, cable drive pulley should also rotate in exact coincidence (no slippage) with the bullgear to provide the transport of the printhead.

CAUTION: On instruments that have a response speed of 15 seconds or slower (use of 7RPM balance motor), it will be necessary to loosen setscrew in motor pinion and disengage motor pinion from bullgear so that the bullgear can be manually rotated.

(C) Continue to manually rotate the bullgear in the same direction until the overtravel mechanical stop is reached. As soon as mechanical stop is reached, clutch should start slipping as evidenced by the stopping of the cable drive pulley (no transport of printhead) while the bullgear is continuously being rotated.

(D) Now rotate the bullgear in the opposite direction. The cable drive pulley should again rotate in exact coincidence (no slippage) with the bullgear to provide the transport of the printhead. As mechanical stop is reached again, clutch should start slipping as evidenced by the stopping of the cable drive pulley (no transport of printhead) while the bullgear is continuously being rotated.

(E) If clutch operates properly, re-engage (if gears had to be previously disengaged as described in CAUTION notation under Step B above) pinion and bullgear; make sure that mesh between pinion and bullgear is properly centered. Retighten setscrew in pinion.

(F) If clutch slips as bullgear is manually rotated between the limits of the mechanical stop (between zero scale and full scale), make clutch adjustment as follows:

To Adjust Clutch (Refer to Figure 3.16-1)

(A) Disassemble the servo gear-train components in the sequence shown.

(B) Use screwdriver and adjust each screw on slip-clutch mechanism as indicated.

(C) Reassemble the servo gear-train components in the sequence shown. Repeat procedures under "Checking Clutch Operation".

(D) If clutch still slips, repeat Steps (A), (B), and (C) above until proper clutch operation is obtained.

CAUTION: Be sure to check clutch operation after each screw adjustment procedure (always make screw adjustments in 1/4-turn increments only). If screws are tightened more than necessary to establish proper clutch operation, clutch life will be prematurely shortened.

(E) If adjusting screws have been turned to their limits and clutch still slips, the two "O" rings in the clutch mechanism are excessively worn and must be replaced. To install new "O" rings, proceed as follows:

Installing New "O" Rings in Slip-Clutch Mechanism (Refer to Figure 3.16-1

(A) Disassemble the servo gear-train components in the sequence shown.

(B) Remove clutch mechanism from gear hub as indicated.

(C) Remove the three adjusting screws from pressure plate. Remove the pressure plate and remove old "O" rings.

(D) Clean inside surface of gear hub and surfaces of bearing race and pressure plate.

(E) Install pressure plate onto bearing race with the three adjusting screws and turn screws all the way down. Then back out screws four turns.

(F) Install two new "O" rings adjacent to each other and between the flanges of the bearing race and pressure plate as shown. Turn each adjusting screw 1-1/2 turns in the clockwise direction.

(G) Wipe a coating of "Vasoline" around the outside of the new "O" rings and inside the gear hub.

(H) Reinstall clutch mechanism into gear hub as indicated.

CAUTION: DO NOT APPLY ANY FORCE AROUND THE PRESSURE PLATE AND BE CAREFUL NOT TO PINCH THE "O" RINGS WHEN REINSTALLING CLUTCH MECHANISM INTO GEAR HUB.

(1) AFTER INSTALLING NEW "O" RINGS, REASSEMBLE THE SERVO GEAR-TRAIN COMPONENTS IN THE SEQUENCE SHOWN. THEN PERFORM PROCEDURES OUTLINED UNDER "CHECKING CLUTCH OPERATION". IF CLUTCH SLIPS, PERFORM PROCEDURES OUTLINED UNDER "TO ADJUST CLUTCH".

FRAME ADJUSTMENTS

ALIGNING CHART DRIVE FRAME TO MAIN MECHANISM FRAME: THE CHART DRIVE FRAME SHOULD BE ALIGNED TO THE MAIN MECHANISM FRAME SO THAT ABOUT 1/16" (± 1/64") CLEARANCE SHOWN IN FIGURE 3.17 EXISTS BETWEEN THE TWO FRAMES WHEN THEY ARE LATCHED TOGETHER. USE OF THE CHART DRIVE SUPPORT PLATE AUTOMATICALLY ESTABLISHES THE CORRECT DIMENSION OF 1/16" (±1/32") AT "DIMENSION A." IF ALIGNMENT OF FRAMES IS OFF, REFER TO FIGURE 3.17 AND PROCEED AS FOLLOWS:

(1) UNLATCH CHART DRIVE FRAME FROM MAIN MECHANISM FRAME, AND SWING OUT CHART FRAME. WITH CHART FRAME SWUNG OUT, MAKE SURE THAT ARM LATCH RETAINING SPRING IS POSITIONED UNDER THE ARM LATCH TO ENSURE THAT PRINTHEAD IS LIFTED AND HELD OFF CHART WHENEVER THE CHART DRIVE FRAME IS UNLATCHED AND SWUNG OUT FROM THE MAIN MECHANISM FRAME. IF LATCH RETAINING SPRING IS OUT OF POSITION, SLIGHTLY BEND SPRING EITHER FORWARD OR BACKWARD SO THAT ITS EDGE RESTS UNDER THE ARM LATCH.

(2) USE ALLEN (HEX) WRENCH AND ADJUST THE TWO SETSCREWS (Z) IN THE RIGHT SIDEPLATE OF THE MAIN FRAME SO THAT THEY EXTEND ABOUT 1/16" (±1/64") ABOVE THE EDGE.

(3) LOOSEN THE TWO SCREWS (Y) WHICH SECURE THE CHARTDRIVE LATCH KEEPER.

(4) BRING FRAMES TOGETHER AND PUSH KEEPER TO LEFT SO THAT CHART DRIVE LATCH WILL EASILY ATTACH TO KEEPER.

(5) PUSH KEEPER TO RIGHT UNTIL CHART FRAME IS DRAWN AGAINST THE TWO SETSCREWS (Z). HOLD KEEPER IN THIS POSITION AND TIGHTEN THE TWO MOUNTING SCREWS (Y).

(6) AFTER CORRECT DIMENSIONS ARE OBTAINED, TEST THE LATCHING AND UNLATCHING OF THE CHART DRIVE FRAME WITH THE MAIN FRAME. LATCHING AND UNLATCHING OPERATION SHOULD BE SMOOTH AND POSITIVE ACTING.

ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM

THE PRINTING AND INPUT SELECTION MECHANISM CONSISTS OF THE COMPONENTS WHICH MECHANICALLY CONTROL THE POINT (STATION) SELECTING AND PRINTING FUNCTIONS OF THE RECORDER. THESE COMPONENTS INCLUDE THE PRINT MOTOR, THE PRINT-MECHANISM GEAR TRAIN, AND THE PRINTHEAD. THE PRINT-MECHANISM GEAR TRAIN CONSISTS OF: (1) THE GEAR COUPLING BETWEEN THE PRINT MOTOR AND GEARBOX, (2) THE GEARBOX ITSELF, AND (3) THE INTERVENING GEAR-TRAIN DRIVE BETWEEN THE GEARBOX OUTPUT CAM AND THE PRINTHEAD.

ALL OF THE IMPORTANT MECHANICAL OPERATIONS INVOLVED IN THE PRINTING AND INPUT SELECTION MUST BE TIMED AND SYNCHRONIZED. A NUMBER OF ADJUSTMENT POINTS ARE PROVIDED TO INSURE THAT PROPER MECHANICAL OPERATION IS MAINTAINED.

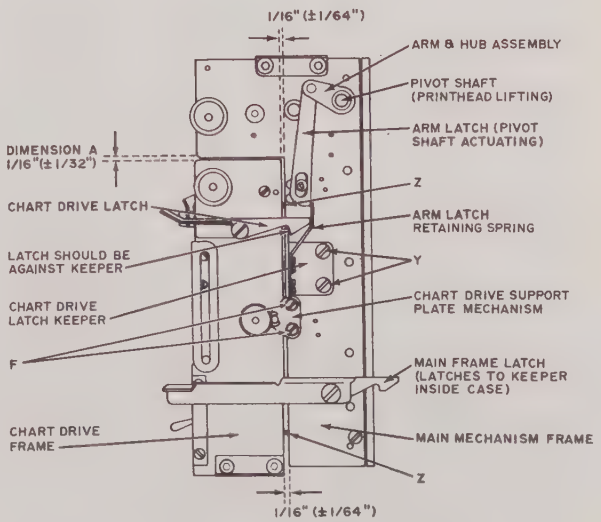


FIGURE 3.17. ALIGNMENT OF FRAMES.

These adjustments have been carefully performed at the factory and should not require further attention in the field. However, if corrective maintenance has been performed which involves a major disassembly and reassembly of components in the print-mechanism gear train, the original adjustments set up at the factory may be destroyed, thus necessitating re-adjustment procedures.

A number of adjustments in the following procedures involve setscrews which have been cemented in place after their adjustment at the factory. The setscrews will usually only require a slight additional torque before they will break loose. In case of difficulty, use small amount of acetone or other suitable solvent to soften cement. If any setscrews have to be replaced, use only cup types.

CAUTION: All adjustments should be made in the sequence as they are listed below.

A. Paralleling Printhead Actuating Shaft to the Point (Station) Advance Pinion (Refer to Figure 3.18)

To Check Parallelism:

(1) Unlatch and swing out chart frame. Measure distance (with depth gauge or other suitable means) between the printhead actuating shaft and the point (station) advance pinion at each end of the main mechanism frame (see dimensions A and B in Figure 3.18).

(2) If the difference between dimension A and dimension B does not exceed 1/64", the parallelism is okay. If difference in measurements exceeds 1/64", correct as follows:

To Correct Parallelism:

(1) With chart frame swung out, make sure that arm latch retaining spring is positioned under the arm latch to ensure that printhead is lifted and held off chart whenever the chart drive frame is unlatched and swung out from the main mechanism frame. If latch retaining spring is out of position, slightly bend spring either forward or backward so that its edge rests under the arm latch. See Figure 3.17.

(2) Loosen two setscrews (x) in the right-arm assembly, two setscrews (y) in the cam follower, and two setscrews (z) in the switch actuating pawl.

(3) Position and secure 5/16" diameter gauge rods (or equivalent spacers) at each end of the mechanism frame between the backplate and the printhead actuating shaft as shown in Figure 3.18.

(4) Press printhead actuating shaft against spacers and tighten two setscrews (x) in right-arm assembly. Seal set-screws with "Glyptal" or an equivalent cement.

B. Synchronization of Cam Follower, Selector Switch Rotor(s), and Printhead Detent Wheel (Refer to Figure 3.18)

(5) Manually turn the gearbox output cam in a counterclockwise direction until notch in cam faces downward.

CAUTION: If no overrunning clutches are used in the gearbox and if print motor speed is 4RPM, it will be necessary to disengage one of the external intermediate-drive gears at the input side of the gearbox before the gearbox output cam can be manually turned.

(6) Place cam follower on pivot shaft so that follower extends through center of hole in backplate. With gauge rods still in place, lift and position cam follower so that end of follower rests firmly against the bottom of the cam notch. Hold cam follower in this position and tighten two setscrews (y). Seal setscrews with "Glyptal" or an equivalent cement.

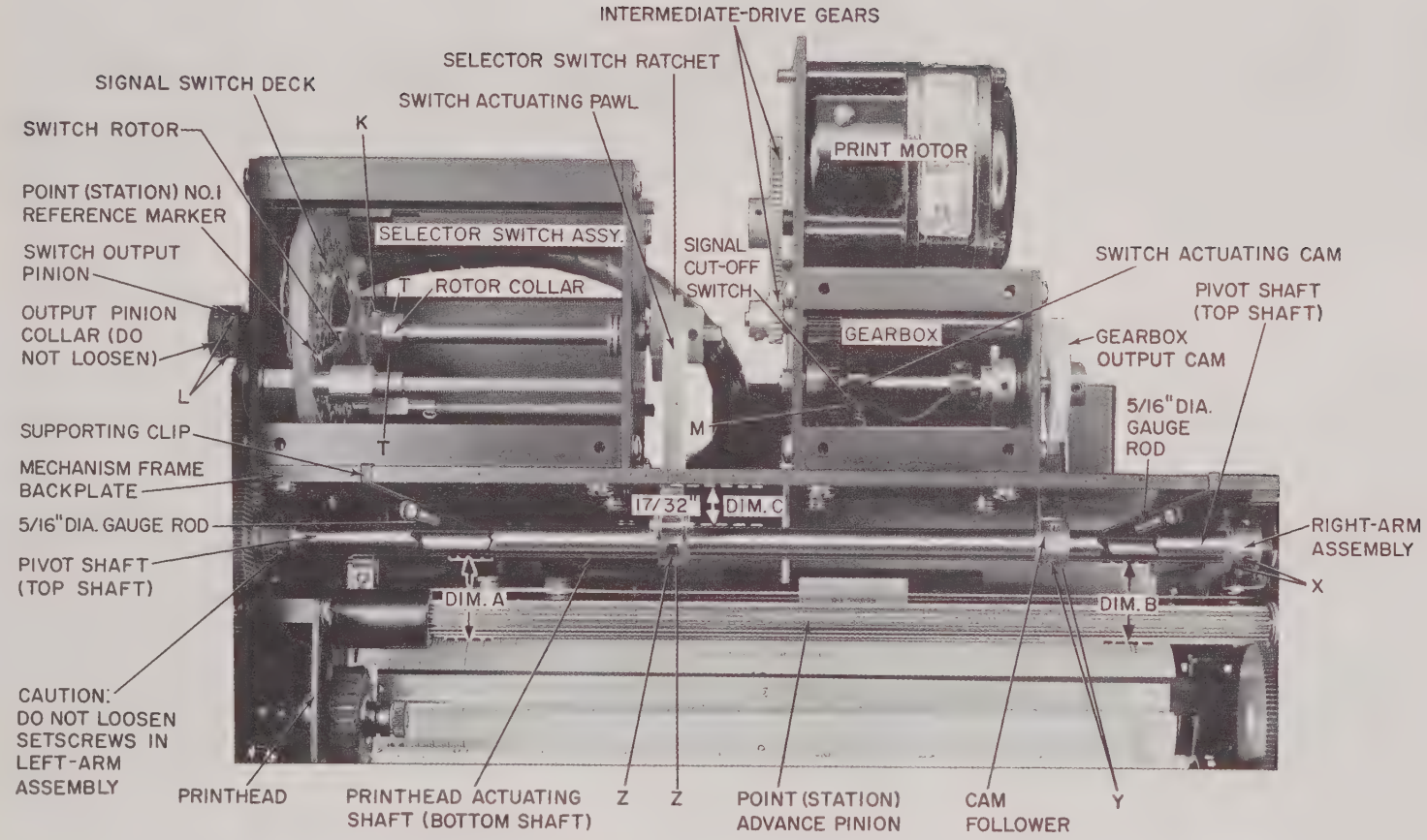


FIGURE 3.18. LOCATION OF MECHANISM ADJUSTMENT POINTS.

(7) With cam follower positioned in cam notch, position switch actuating pawl arm on pivot shaft so that pawl extends through center of hole in backplate and 17/32" dimension (see dimension C in Figure 3.18) is obtained between the backplate and the center line of the pawl mounting pin. Tighten the two setscrews (z). Seal setscrews with "Glyptal" or an equivalent cement.

(8) Remove 5/16" diameter gauge rods. Latch chart frame to main mechanism frame.

(9) Manually turn gearbox output cam counterclockwise so that cam follower rides out of the notch and onto the highest part of the cam lobe (cam follower driven to lowest position).

(10) Loosen screw (k) in rotor hub and two setscrews (t) in rotor collar. Move rotor and collar away from switch contacts. Then move rotor and collar toward contacts until rotor arms just touch a contact pair. Move rotor and collar an additional 1/32" toward contacts and then retighten setscrews (t) in rotor collar. Seal setscrews with "Glyptal" or an equivalent cement. Keep zero backlash between switch actuating pawl and the selector switch ratchet, and turn rotor until its arms are centered on a contact pair. Retighten screw (k) in rotor hub.

(11) Repeat Step 10 for all rotors used in a multi-deck switch assembly, and synchronize rotors so that they are centered on the same point (or station) contact pair.

NOTE: The basic multipoint recorder (no optional features included) has a single 24-position signal switch deck as shown in Figure 3.18. This switch deck may be of the shorting type (make-before-break) or non-shorting type (break-before-make) as ordered by the customer. The break-before-make (bbm) switch deck has 48 contacts in each circular row instead of the 24 contacts which are used in the make-before-break (mbb) switch deck. However, every other contact of the bbm switch deck is inactive and is only used to guide the rotor to the next live contact.

An additional switch deck is used when the recorder is equipped with any one of the following optional features: programmed printing, programmed dual-range selection, programmed dual-range selection with programmed printing, and selective alarms. Therefore, by use of optional features, the selector switch assembly may be composed of up to three switch decks. The program switch deck (used for either programmed printing option or programmed dual-range option) is always of the make-before-break (mbb) type and consists of 24 contacts in each circular row. The selective alarm switch deck is always of the break-before-make (bbm) type and consists of 48 contacts in each circular row. Refer to the instrument DATA SHEET to determine optional features incorporated into a particular recorder. Information regarding optional features is contained in the APPENDIX, PART 6.

The arrangement of the switch decks in the selector switch assembly (left to right arrangement as viewed from the front of the mechanism) for the various options employed in the recorder is as follows:

No Options--Signal switch deck

<u>No Options</u>--Signal switch deck only (see Figure 3.18).

<u>Programmed Printing Only</u>--Program switch deck, signal switch deck.

<u>Programmed Dual-Range Selection Only</u>--Program switch deck, signal switch deck.

SELECTIVE ALARMS ONLY--SIGNAL SWITCH DECK, SELECTIVE ALARM SWITCH DECK.

PROGRAMMED PRINTING WITH PROGRAMMED DUAL RANGE AND SELECTIVE ALARMS--PROGRAM SWITCH DECK, SIGNAL SWITCH DECK, SELECTIVE ALARM SWITCH DECK.

IF THE PROGRAMMED PRINTING OPTION IS INCLUDED ON RECORDER, AN ADDITIONAL ADJUSTMENT MAY BE REQUIRED OF THE ROTOR ASSOCIATED WITH THE PROGRAM SWITCH DECK. THIS ADJUSTMENT WILL BE FOUND IN THE INFORMATION APPLICABLE TO THE PROGRAMMED PRINTING OPTION IN THE APPENDIX, PART 6.

(12) MANUALLY TURN GEARBOX OUTPUT CAM THROUGH SEVERAL REVOLUTIONS AND CHECK TO SEE THAT ROTOR(S) ADVANCES TO THE CENTER OF THE NEXT CONTACT PAIR WHEN CAM FOLLOWER RIDES OUT OF THE CAM NOTCH AND ONTO THE PEAK OF THE CAM LOBE. REPEAT STEPS 9, 10, 11, AND 12 UNTIL PROPER RESULTS ARE OBTAINED. SEAL SCREW (K) WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

(13) NOTE THAT SWITCH ACTUATING PAWL DROPS BACK ABOUT 1/32" AFTER ROTOR(S) IS ADVANCED.

(14) MANUALLY DISPLACE PRINTHEAD TO 0% OF SCALE.

(15) MANUALLY TURN GEARBOX OUTPUT CAM SO THAT CAM FOLLOWER RIDES ON THE CIRCULAR PORTION OF THE CAM LOBE. LOOSEN THE TWO PRINTHEAD BRACKET MOUNTING SCREWS (SEE FIGURE 3.19) AND MOVE BRACKET FORWARD OR BACKWARD TO OBTAIN 3/16" (±1/64") DIMENSION BETWEEN TYPE CHARACTERS ON PRINT WHEEL AND THE CHART DRIVE ROLLER. RETIGHTEN THE TWO BRACKET MOUNTING SCREWS.

(16) MANUALLY DISPLACE PRINTHEAD TO 100% OF SCALE AND CHECK FOR 3/16" (±1/64") CLEARANCE BETWEEN TYPE CHARACTERS ON PRINT WHEEL AND THE CHART DRIVE ROLLER. IF NOT OKAY, REFER TO FIGURE 3.17 AND LOOSEN THE TWO SCREWS (F) WHICH SECURE THE CHART DRIVE SUPPORT PLATE. POSITION CHART DRIVE SUPPORT PLATE EITHER UPWARD OR DOWNWARD TO OBTAIN 3/16" (±1/64") DIMENSION. RETIGHTEN TWO SCREWS (F).

(17) MANUALLY TURN GEARBOX OUTPUT CAM UNTIL CAM FOLLOWER DROPS INTO THE CAM NOTCH. CONTINUE TO SLOWLY TURN OUTPUT CAM SO THAT CAM FOLLOWER BEGINS TO RIDE OUT OF THE CAM NOTCH. WHEN THE PRINTHEAD HAS RISEN ABOUT 1/3 OF ITS TOTAL UPWARD TRAVEL, THE PLAY OF THE LARGE IDLER GEAR IN THE PRINTHEAD SHOULD BE TAKEN UP AND THE DETENT WHEEL IN THE PRINTHEAD SHOULD BEGIN TO MOVE. JUST BEFORE CAM FOLLOWER RIDES ONTO THE PEAK OF THE CAM LOBE, YOU SHOULD HEAR THE "CLICK" SOUND OF THE DETENT SPRING SEATING ITSELF INTO THE NEXT NOTCH ON THE DETENT WHEEL. PLAY SHOULD IMMEDIATELY BE FELT IN THE LARGE IDLER GEAR IN THE PRINTHEAD. IF THE DETENT WHEEL IN THE PRINTHEAD DOES NOT ADVANCE TO A NEW NOTCH BUT FALLS BACK INTO SAME NOTCH, LOOSEN THE TWO SETSCREWS (L) IN SELECTOR SWITCH OUTPUT PINION (FIGURE 3.18) AND TURN OUTPUT PINION COUNTERCLOCKWISE (AS VIEWED FROM OUTPUT END) FOR FASTER TAKEUP OF BACKLASH. RETIGHTEN SETSCREWS (L) AND TEST AGAIN. MAKE NECESSARY ADJUSTMENTS OF OUTPUT PINION UNTIL PROPER RESULTS ARE OBTAINED. SEAL SETSCREWS WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

NOTE: IF THE DETENT SPRING IN THE PRINTHEAD ADVANCES TO THE NEXT NOTCH ON THE DETENT WHEEL BUT NO PLAY CAN BE FELT IN THE

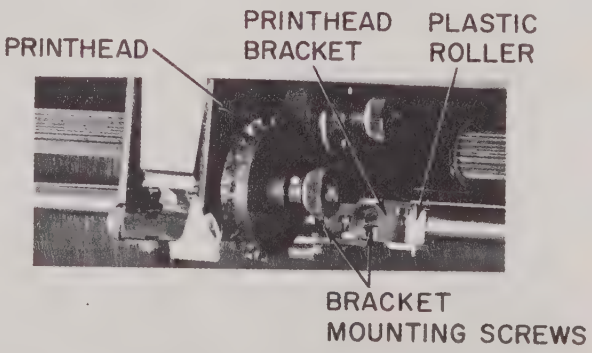


FIGURE 3.19. PRINTHEAD HEIGHT ADJUSTMENT.

LARGE IDLER GEAR IN PRINTHEAD IMMEDIATELY AFTER "CLICK" SOUND OF THE DETENT SPRING, LOOSEN TWO SETSCREWS (L) IN OUTPUT PINION AND TURN OUTPUT PINION CLOCKWISE TO RETARD TAKEUP OF BACKLASH. RETIGHTEN SETSCREWS AND TEST AGAIN. MAKE NECESSARY ADJUSTMENTS OF OUTPUT PINION UNTIL PROPER RESULTS ARE OBTAINED. SEAL SETSCREWS WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

C. SIGNAL CUTOFF SWITCH ADJUSTMENT (REFER TO FIGURE 3.18)

(18) UNPLUG CONNECTOR JACK (J201) FROM AMPLIFIER PLUG (P201).

(19) MANUALLY TURN GEARBOX OUTPUT CAM SO THAT CAM FOLLOWER IS RIDING ON CAM LOBE WHERE PEAKED PORTION SLOPES INTO THE CIRCULAR PORTION.

(20) CONNECT AN OHMMETER ACROSS TERMINALS 3 AND 4 OF TERMINAL BLOCK TB401. OHMMETER SHOULD READ INFINITE OHMS.

(21) SLOWLY TURN GEARBOX OUTPUT CAM AND OBSERVE THE OHMMETER. THE OHMMETER SHOULD READ ZERO OHMS THREE OR FOUR DEGREES BEFORE THE CAM FOLLOWER DROPS INTO THE CAM NOTCH--THUS INDICATING THAT THE CUTOFF SWITCH HAS CLOSED.

(22) IF THE SIGNAL CUTOFF SWITCH CLOSES TOO SOON OR TOO LATE, LOOSEN THE SETSCREW (M) IN THE SWITCH ACTUATING CAM AND POSITION CAM TO OBTAIN THE CORRECT TIMING. RETIGHTEN SETSCREW AND SEAL WITH "GLYPTAL" OR AN EQUIVALENT CEMENT. PLUG CONNECTOR JACK (J201) INTO AMPLIFIER PLUG (P201).

NOTE: ADJUSTMENTS OF THE SELECTIVE ALARM SWITCH (ASSOCIATED WITH SELECTIVE ALARM OPTIONAL FEATURE) AND THE SKIP DELAY SWITCH (ASSOCIATED WITH PROGRAMMED PRINTING OPTIONAL FEATURE) WILL BE FOUND IN THE INFORMATION APPLICABLE TO THE SPECIFIC OPTIONS EMPLOYED ON THE RECORDER. REFER TO INSTRUMENT DATA SHEET TO DETERMINE OPTIONAL FEATURES INCORPORATED INTO A PARTICULAR RECORDER. INFORMATION REGARDING OPTIONAL FEATURES IS CONTAINED IN THE APPENDIX, PART 6.

D. SYNCHRONIZATION OF PRINT WHEEL AND POINT (STATION) INDICATOR WHEEL WITH POINT (STATION) SELECTION OF SELECTOR SWITCH ASSEMBLY

(23) MANUALLY TURN THE POINT (STATION) ADVANCE CONTROL IN THE COUNTERCLOCKWISE DIRECTION UNTIL ROTOR(S) OF SWITCH DECK(S) IS POSITIONED ON POINT (STATION) NUMBER 1 CONTACTS. POINT (OR STATION) NUMBER 1 ON THE SELECTOR SWITCH DECK(S) IS IDENTIFIED BY A REFERENCE NUMBER "1" STAMPED ON THE SWITCH DECK. REFER TO FIGURE 3.18 FOR LOCATION OF REFERENCE MARKER.

(24) LOOSEN KNURLED NUT ON PRINT WHEEL SHAFT. BACK OFF TAPERED RETAINING SLEEVE FROM PRINT WHEEL HUB SO THAT PRINT WHEEL CAN BE FREELY TURNED ON ITS SHAFT.

(25) HOLD INK WHEEL STATIONARY AND MANUALLY TURN PRINT WHEEL UNTIL A NUMBER 1 ON PRINT WHEEL FACES DIRECTLY DOWN AND PERPENDICULAR TO THE CHART. POINT 1 IS IDENTIFIED BY A WHITE DOT ON SIDE OF WHEEL.

(26) NOW SNUG THE TAPERED RETAINING SLEEVE AGAINST THE PRINT WHEEL AND RETIGHTEN KNURLED NUT.

(27) DISENGAGE SWITCH ACTUATING PAWL FROM SELECTOR SWITCH RATCHET AND SECURE PAWL IN A DISENGAGED POSITION.

(28) MANUALLY TURN THE GEARBOX OUTPUT CAM COUNTERCLOCKWISE TO ALLOW PRINTING OF POINT (STATION) NUMBER 1 ON THE CHART. REPEAT THROUGH SEVERAL PRINTING CYCLES AND MANUALLY MOVE PRINTHEAD TO DIFFERENT LATERAL POSITIONS BETWEEN PRINT-OUTS SO THAT PRINTING DOES NOT OCCUR AT THE SAME PLACE ON THE CHART. OBSERVE PRINTING.

NOTE: IF PRINTING OF POINT (STATION) NUMBER 1 BECOMES FADED AFTER SEVERAL PRINT-OUTS, RE-INK THE PRINT WHEEL BY TURNING THE POINT (STATION) ADVANCE CONTROL ONE OR TWO REVOLUTIONS IN THE COUNTER-CLOCKWISE DIRECTION--REMEMBERING TO RETURN THE ROTOR(S) OF SWITCH DECK(S) BACK TO POINT (STATION) NUMBER 1 CONTACTS.

(29) THE ENTIRE TYPE CHARACTER OF POINT (STATION) NUMBER 1 SHOULD BE PRINTED WITHOUT ANY PARTIAL PRINTING FROM ADJACENT TYPE CHARACTERS ON THE PRINT WHEEL.

(30) IF PROPER PRINTING RESULTS ARE NOT OBTAINED, LOOSEN THE RETAINING NUT AND BACK OFF THE TAPERED RETAINING SLEEVE. SLIGHTLY REPOSITION THE PRINT WHEEL IN THE REQUIRED DIRECTION, RETIGHTEN RETAINING NUT, AND RECHECK PRINTING. REPEAT STEPS 28, 29, AND 30 UNTIL PROPER PRINTING RESULTS ARE OBTAINED.

(31) LOOSEN SCREW WHICH SECURES THE POINT (STATION) INDICATOR WHEEL AND POSITION WHEEL SO THAT A NUMBER 1 ON WHEEL IS CENTERED IN THE WINDOW OPENING IN THE SCALE. RETIGHTEN SCREW.

(32) AFTER PROPER ALIGNMENT BETWEEN THE PRINT WHEEL AND POINT (STATION) SELECTION OF SELECTOR SWITCH ASSEMBLY IS OBTAINED, SCRIBE A MARK ON THE PRINT WHEEL HUB IN LINE WITH THE CENTER OF THE PIN IN THE TAPERED RETAINING SLEEVE (SEE FIGURE 3.14). THIS MARK PROVIDES A MECHANICAL REFERENCING POINT AND IS USED AS A QUICK METHOD OF RE-ALIGNING THE PRINT WHEEL WHENEVER IT IS REMOVED AND RE-INSTALLED IN THE FUTURE.

(33) ALLOW THE SWITCH ACTUATING PAWL TO ENGAGE THE SELECTOR SWITCH RATCHET IN THE NORMAL MANNER.

(34) IF THE PRINTING IS EITHER TOO LIGHT OR TOO HEAVY, ADJUST THE TENSION OF THE PRINTHEAD IMPACT SPRING AS DESCRIBED UNDER TOPIC HEADING "PRINTHEAD IMPACT SPRING ADJUSTMENT."

E. SYNCHRONIZATION OF MULTICOLOR INK WHEEL WITH PRINT WHEEL

(35) AFTER PRINT WHEEL IS MECHANICALLY ALIGNED WITH THE POINT (STATION) SELECTION OF THE SELECTOR SWITCH ASSEMBLY, A MULTICOLOR INK WHEEL MUST BE INSTALLED SO THAT IT IS MECHANICALLY SYNCHRONIZED WITH THE PRINT WHEEL TO ASSURE THE PROPER COLOR SEQUENCE OF PRINTING FOR THE VARIOUS POINTS (OR STATIONS) ON THE PRINT WHEEL (SEE TABLES 3.4 AND 3.5). NO SPECIAL MECHANICAL ALIGNMENT INSTRUCTIONS ARE REQUIRED FOR A UNICOLOR INK WHEEL SINCE THE SAME COLOR IS PRINTED ON ALL POINTS (STATIONS).

(36) A DUAL-DISC (INNER AND OUTER) ASSEMBLY MOUNTED AGAINST THE METAL FLANGE OF THE MULTICOLOR INK WHEEL IS KEYED TO THE INK WHEEL SHAFT AND A LOCATING PIN ON THE METAL FLANGE FOR THE PURPOSE OF ALIGNING THE INK WHEEL TO THE PRINT WHEEL. THE INK WHEEL IS KEPT ALIGNED TO THE PRINT WHEEL BY INSTALLING THE INK WHEEL AND DISC ASSEMBLY AS FOLLOWS:

(A) WITH KNURLED NUT AND LOCKWASHER REMOVED FROM INK WHEEL SHAFT, PLACE INK WHEEL ON SHAFT.

(B) ALIGN KEY IN OUTER DISC WITH KEYWAY IN SHAFT, AND SLIDE DISC ASSEMBLY ONTO SHAFT.

(C) ROTATE INK WHEEL UNTIL LOCATING PIN ON INK WHEEL'S METAL FLANGE ENGAGES NOTCH IN RIM OF INNER DISC.

(D) REPLACE LOCKWASHER ON SHAFT AND SECURE WHEEL BY TIGHTENING KNURLED NUT WITH FINGERS.

(E) THE INK WHEEL IS NOW MECHANICALLY ALIGNED TO THE PRINT WHEEL.

(37) ADJUSTMENT OF DISC ASSEMBLY: UNDER NORMAL ROUTINE MAINTENANCE PROCEDURES, ADJUSTMENT OF THE DISC ASSEMBLY WILL NOT BE REQUIRED; HOWEVER, IF THE 2 SMALL SCREWS IN THE DISC ASSEMBLY HAVE BEEN INADVERTENTLY LOOSENED TO ALLOW THE

2 DISCS TO CHANGE THEIR RELATIVE POSITIONS TO ONE ANOTHER, OR IF THE DISC ASSEMBLY ITSELF IS REPLACED IN THE FIELD, ADJUST DISC ASSEMBLY AS FOLLOWS:

(A) WITH NUT, LOCKWASHER AND DISC ASSEMBLY REMOVED, PLACE MULTICOLOR INK WHEEL IN OPERATING POSITION ON ITS SHAFT.

(B) LOOSEN 2 SMALL SCREWS IN THE DISC ASSEMBLY SO THAT DISCS ARE FREE TO ROTATE FULL DISTANCE OF SCREW SLOTS IN OUTER DISC.

(C) SLIDE DISC ASSEMBLY ON WHEEL SHAFT BY POSITIONING KEY OF OUTER DISC IN SHAFT KEYWAY.

(D) HOLDING DISC ASSEMBLY STATIONARY, ROTATE INK WHEEL UNTIL LOCATING PIN ON WHEEL'S METAL FLANGE ENGAGES NOTCH IN RIM OF INNER DISC.

NOTE: WHEN DISC ASSEMBLY IS PROPERLY KEYED, IT WILL LAY FLAT AGAINST METAL FLANGE OF INK WHEEL.

(E) TURN POINT ADVANCE CONTROL COUNTERCLOCKWISE UNTIL POINT NUMBER 1 ON PRINT WHEEL (WHITE DOT ON SIDE OF PRINT WHEEL) IS EXACTLY TANGENT TO INK WHEEL.

(F) HOLDING PRINT WHEEL STATIONARY, ROTATE INK WHEEL UNTIL HOLE IN METAL FLANGE ON INK WHEEL AND WHITE DOT ON PRINT WHEEL LINE UP SQUARELY BETWEEN THE TWO WHEEL SHAFTS. THE PROPER COLOR INK PAD (RED) SHOULD NOW BE TOUCHING ONLY THE TYPE SYMBOL FOR POINT NUMBER 1.

NOTE: IF SMALL SCREWS HIT ENDS OF SLOTS IN OUTER DISC BEFORE PROPER ALIGNMENT POINT IS REACHED, REMOVE THE 2 SCREWS, TURN OUTER DISC OVER, AND REPEAT ABOVE STEP.

(G) HOLDING BOTH WHEELS STATIONARY, CAREFULLY TIGHTEN 2 SMALL SCREWS IN DISC ASSEMBLY.

(H) REPLACE LOCKWASHER ON SHAFT, AND FINGER TIGHTEN THE KNURLED NUT.

(I) CHECK ADJUSTMENT OF DISC ASSEMBLY BY PERFORMING STEP 38.

(38) MANUALLY TURN THE GEARBOX OUTPUT CAM COUNTERCLOCKWISE TO ALLOW PRINTING ON THE CHART. REPEAT THROUGH SEVERAL PRINTING CYCLES AND MANUALLY MOVE PRINTHEAD TO DIFFERENT LATERAL POSITIONS BETWEEN PRINT-OUTS SO THAT PRINTING DOES NOT OCCUR AT THE SAME PLACE ON THE CHART. OBSERVE PRINTING. IF FRINGES OF MORE THAN ONE COLOR ARE SIMULTANEOUSLY BEING PRINTED, DISC ASSEMBLY STILL NEEDS SLIGHT READJUSTMENT. REPEAT STEPS 37 AND 38 SO THAT ONLY ONE COLOR AT A TIME IS BEING PRINTED FOR EACH POINT (WITHOUT COLOR FRINGING FROM ADJACENT COLOR PADS).

NOTE: IF A GEAR HAD TO BE PREVIOUSLY DISENGAGED IN ORDER TO MANUALLY TURN THE GEARBOX OUTPUT CAM (SEE STEP 5), RE-ENGAGE AND SECURE GEAR.

FIELD CONVERSION APPLICATIONS

CHANGING NUMBER-OF-POINTS (-STATIONS)

IF THE UNIVERSAL SIGNAL INPUT PANEL IS FACTORY PREWIRED WITH THE NUMBER-OF-POINTS PLUG (P301), CHANGING THE NUMBER-OF-POINTS CAN READILY BE PERFORMED IN THE FIELD. POINT CONVERSION KITS ARE AVAILABLE FOR 2-, 3-, 4-, 6-, 8-, 10-, 12-, 16-, 18-, 20-, AND 24-POINT SELECTION. AS SHOWN IN FIGURE 3.20, EACH KIT CONSISTS OF A PRINT WHEEL ASSEMBLY, A POINT (STATION) INDICATOR WHEEL, AND A NUMBER-OF-POINTS (-STATIONS) SOCKET. THE PART NUMBERS FOR THE COMPLETE KITS AND FOR THE INDIVIDUAL COMPONENTS ARE SHOWN IN TABLE 3.8.

THE FACTORY PREWIRED POINTS (STATIONS) SOCKET ACCOMPLISHES THE CIRCUIT PARALLELING OF VARIOUS POINT (STATION) INPUT TERMINALS AS INDICATED IN TABLE 3.9.

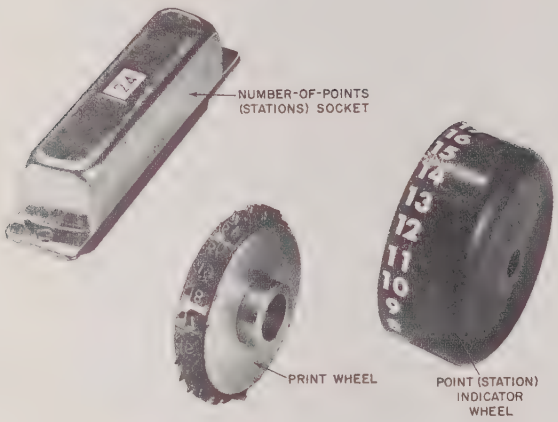


FIGURE 3.20. POINT (STATION) CHANGE COMPONENTS.

FOR A 24-POINT INPUT SELECTION, A DUST COVER IS PLACED OVER THE POINTS PLUG (P301). IN THIS MANNER, ALL POINT (STATION) INPUT TERMINALS REMAIN ISOLATED FROM EACH OTHER TO ENABLE A 24-POINT INPUT SELECTION. WHEN ANY ONE OF THE PARTICULAR POINTS SOCKETS LESS THAN 24 IS INSERTED, THE PARTICULAR SOCKET IS PREWIRED SO THAT SPECIFIC PAIRS OF INPUT TERMINALS ARE EFFECTIVELY CONNECTED IN PARALLEL, THUS CHANGING THE NUMBER-OF-POINT SELECTION TO THE NUMBER INDICATED ON THE POINTS SOCKET (SEE TABLE 3.9).

TO CHANGE THE NUMBER-OF POINT (-STATION) SELECTION, PROCEED AS FOLLOWS:

(1) UNPLUG ORIGINAL POINTS (STATIONS) SOCKET FROM MULTIPLE-SIGNAL INPUT PANEL AND INSERT NEW ONE.

(2) REMOVE COVER FROM SELECTOR SWITCH ASSEMBLY. MANUALLY TURN THE POINT (STATION) ADVANCE CONTROL IN THE COUNTERCLOCKWISE DIRECTION UNTIL ROTOR(S) OF SWITCH DECK(S) IS POSITIONED ON POINT (STATION) NUMBER 1 CONTACTS. POINT NUMBER 1 ON THE SELECTOR SWITCH DECK(S) IS IDENTIFIED BY A REFERENCE NUMBER "1" STAMPED ON THE SWITCH DECK. REFER TO FIGURE 3.18 FOR LOCATION OF REFERENCE MARKER.

(3) REMOVE KNURLED NUT, LOCKWASHER, AND TAPERED RETAINING SLEEVE FROM PRINT WHEEL SHAFT. REMOVE ORIGINAL PRINT WHEEL.

(4) INSTALL NEW PRINT WHEEL ON SHAFT AND REPLACE THE TAPERED RETAINING SLEEVE. DO NOT SNUG-FIT THE SLEEVE AGAINST THE PRINT WHEEL SO THAT THE WHEEL CAN BE FREELY TURNED ON ITS SHAFT.

(5) HOLD INK WHEEL STATIONARY AND MANUALLY TURN PRINT WHEEL UNTIL A NUMBER 1 ON PRINT WHEEL FACES DIRECTLY DOWN AND PERPENDICULAR TO THE CHART. POINT 1 IS IDENTIFIED BY A WHITE DOT ON SIDE OF WHEEL.

(6) NOW SNUG THE TAPERED RETAINING SLEEVE AGAINST THE PRINT WHEEL AND INSTALL LOCKWASHER AND KNURLED NUT ON SHAFT. FINGER-TIGHTEN THE NUT.

(7) TO INK THE PRINT WHEEL, TURN THE POINT (STATION) ADVANCE CONTROL TWO OR THREE REVOLUTIONS IN THE COUNTERCLOCKWISE DIRECTION. REMEMBER TO

TABLE 3.8. COMPONENT PARTS FOR VARIOUS NUMBER-OF-POINTS (-STATIONS) KITS.

NUMBER-OF-POINTS (-STATIONS)	PRINT WHEEL ASSEMBLY	INDICATOR WHEEL	SOCKET	KIT
2	51019-2	51210-2	401156-2	51215-2
3	51019-3	51210-3	401156-3	51215-3
4	51019-4	51210-4	401156-4	51215-4
6	51019-6	51210-6	401156-6	51215-6
8	51019-8	51210-8	401156-8	51215-8
10	51019-10	51210-10	401156-10	51215-10
12	51019-12	51210-12	401156-12	51215-12
16	51019-16	51210-16	401156-16	51215-16
18	51019-18	51210-18	401156-18	51215-18
20	51019-20	51210-20	401156-20	51215-20
24	51019-24	51210-24	401156-24†	51215-24

†DUST COVER. NO SOCKET REQUIRED.

TABLE 3.9. NUMBER-OF-POINTS CONNECTION DATA.

NUMBER-OF-POINTS (-STATIONS) SOCKET OR FIXED NUMBER-OF-POINTS WIRING	POINT (STATION) INPUT TERMINALS PARALLELED	CONNECT INPUT SIGNALS TO FOLLOWING POINT (STATION) TERMINALS ON INPUT PANEL	LEAVE FOLLOWING POINT (STATION) INPUT TERMINALS OPEN ON INPUT PANEL
2	1,3,5,7,9,11,13,15,17,19,21,&23 2,4,6,8,10,12,14,16,18,20,22,&24	1 AND 2	3 THRU 24
3	1, 4, 7, 10, 13, 16, 19, & 22 2, 5, 8, 11, 14, 17, 20, & 23 3, 6, 9, 12, 15, 18, 21, & 24	1 THRU 3	4 THRU 24
4	1, 5, 9, 13, 17, & 21 2, 6, 10, 14, 18, & 22 3, 7, 11, 15, 19, & 23 4, 8, 12, 16, 20, & 24	1 THRU 4	5 THRU 24
6	1, 7, 13, & 19 | 4, 10, 16, & 22 2, 8, 14, & 20 | 5, 11, 17, & 23 3, 9, 15, & 21 | 6, 12, 18, & 24	1 THRU 6	7 THRU 24
8	1, 9, & 17 | 5, 13, & 21 2, 10, & 18 | 6, 14, & 22 3, 11, & 19 | 7, 15, & 23 4, 12, & 20 | 8, 16, & 24	1 THRU 8	9 THRU 24
10	1 & 13 | 6, 12, 18, & 24 2 & 14 | 7 & 19 3 & 15 | 8 & 20 4 & 16 | 9 & 21 5, 11, 17, & 23 | 10 & 22	1 THRU 10	11 THRU 24
12	1 & 13 | 4 & 16 | 7 & 19 | 10 & 22 2 & 14 | 5 & 17 | 8 & 20 | 11 & 23 3 & 15 | 6 & 18 | 9 & 21 | 12 & 24	1 THRU 12	13 THRU 24
16	5 & 17 | 7 & 19 | 9 & 21 | 11 & 23 6 & 18 | 8 & 20 | 10 & 22 | 12 & 24	1 THRU 16	17 THRU 24
18	7 & 19 | 10 & 22 8 & 20 | 11 & 23 9 & 21 | 12 & 24	1 THRU 18	19 THRU 24
20	9 & 21 | 10 & 22 | 11 & 23 | 12 & 24	1 THRU 20	21 THRU 24
24	NONE (ALL INPUT TERMINALS REMAIN ISOLATED FROM EACH OTHER)	1 THRU 24	NONE

RETURN THE ROTOR(S) OF SWITCH DECK(S) BACK TO POINT (STATION) NUMBER 1 CONTACTS.

(8) DISENGAGE SWITCH ACTUATING PAWL FROM SELECTOR SWITCH RATCHET (FIGURE 3.18) AND SECURE PAWL IN A DISENGAGED POSITION.

(9) TURN ON THE INSTRUMENT AND ALLOW POINT NUMBER 1 ON PRINT WHEEL TO PRINT OUT SEVERAL TIMES ON THE CHART. MANUALLY MOVE PRINTHEAD TO DIFFERENT LATERAL POSITIONS BETWEEN PRINT-OUTS SO THAT PRINTING DOES NOT OCCUR AT THE SAME PLACE ON THE CHART.

(10) OBSERVE PRINTING. THE ENTIRE TYPE CHARACTERS OF POINT (STATION) NUMBER 1 SHOULD BE PRINTED WITHOUT ANY PARTIAL PRINTING FROM THE ADJACENT TYPE CHARACTERS ON THE PRINT WHEEL.

(11) IF PROPER PRINTING RESULTS ARE NOT OBTAINED, LOOSEN THE RETAINING NUT AND BACK OFF THE TAPERED RETAINING SLEEVE. SLIGHTLY REPOSITION THE PRINT WHEEL IN THE REQUIRED DIRECTION, RETIGHTEN RETAINING NUT, AND RECHECK PRINTING. REPEAT STEPS 9, 10, AND 11 UNTIL PROPER PRINTING RESULTS ARE OBTAINED.

(12) REMOVE ORIGINAL POINT (STATION) INDICATOR WHEEL AND INSTALL NEW INDICATOR WHEEL SO THAT A NUMBER 1 ON WHEEL IS CENTERED IN THE WINDOW OPENING IN THE SCALE.

(13) AFTER PROPER ALIGNMENT BETWEEN THE PRINT WHEEL AND POINT (STATION) NUMBER 1 OF THE SELECTOR SWITCH ASSEMBLY IS OBTAINED, SCRIBE A MARK ON THE PRINT WHEEL HUB IN LINE WITH THE CENTER OF THE PIN IN THE TAPERED RETAINING SLEEVE (SEE FIGURE 3.14). THIS MARK PROVIDES A MECHANICAL REFERENCING POINT AND IS USED AS A QUICK METHOD OF RE-ALIGNING THE PRINT WHEEL WHENEVER IT IS REMOVED AND RE-INSTALLED IN THE FUTURE.

(14) ALLOW THE SWITCH ACTUATING PAWL TO ENGAGE THE SELECTOR SWITCH RATCHET IN THE NORMAL MANNER.

(15) IF THE PRINTING IS EITHER TOO LIGHT OR TOO HEAVY, ADJUST THE TENSION OF THE PRINTHEAD IMPACT SPRING AS DESCRIBED UNDER TOPIC HEADING "PRINTHEAD IMPACT SPRING ADJUSTMENT."

NOTE: CHANGING TO ANOTHER NUMBER-OF-POINT (STATION) SELECTION MAY ALSO REQUIRE A REPLACEMENT OF THE ENTIRE MULTICOLOR INK WHEEL ASSEMBLY OR A REARRANGEMENT OF THE MULTICOLOR INK PADS IN THE EXISTING INK WHEEL IF IT IS DESIRED TO CONFORM TO THE STANDARD COLOR-PRINTING SEQUENCE SHOWN IN TABLES 3.4 AND 3.5. REFER TO SUBJECT ENTITLED "MULTICOLOR RE-INKING PROCEDURES."

AFTER A POINT (STATION) CHANGE CONVERSION HAS BEEN COMPLETED, MAKE SIGNAL INPUT CONNECTIONS TO MULTIPLE-SIGNAL INPUT PANEL AS INDICATED IN TABLE 3.9.

CHANGING PRINT FREQUENCY

THE PRINT FREQUENCY AT WHICH THE MEASURED SIGNALS ARE PRINTED OUT ON THE CHART IS DETERMINED BY THE FOLLOWING FOUR COMPONENTS: (1) THE PRINT MOTOR, (2) THE MOTOR OUTPUT (DRIVING) INTERMEDIATE GEAR, (3) THE GEARBOX INPUT (DRIVEN) INTERMEDIATE GEAR, AND (4) THE GEAR-SHIFT MECHANISM WITHIN THE GEARBOX ITSELF.

THE BASIC MULTIPOINT RECORDER (RECORDER NOT OPTIONALLY EQUIPPED WITH PROGRAMMED PRINTING OR THE ELECTRICALLY-CONTROLLED, DUAL PRINT FREQUENCY) USES A PRINT MECHANISM GEARBOX THAT PROVIDES A SELECTION OF TWO DIFFERENT PRINT FREQUENCIES FOR EACH SET OR COMBINATION OF EXTERNAL INTERMEDIATE-DRIVE GEARS. THIS TWO-SPEED SELECTION (IN THE SPEED RATIO OF 4:1) IS ACCOMPLISHED BY MANUALLY SHIFTING A GEAR AND PINION ASSEMBLY THAT IS LOCATED WITHIN THE GEARBOX ITSELF.

WITH THE GEAR AND PINION ASSEMBLY SHIFTED TO POSITION "A" AS SHOWN IN FIGURE 3.21, THE FASTER SPEED (TERMED THE BASIC PRINT FREQUENCY) OF EACH TWO-SPEED SELECTION IS PROVIDED AT THE GEARBOX OUTPUT CAM. WITH THE GEAR AND PINION ASSEMBLY SHIFTED TO POSITION "B" AS SHOWN IN FIGURE 3.21, A SPEED OF 1/4 TIMES THE BASIC PRINT SPEED IS PROVIDED AT THE GEARBOX OUTPUT CAM.

THE RESULTING PRINT FREQUENCIES (OUTPUT SPEEDS) OF THE MECHANICALLY SPEED-SWITCHED GEARBOX MAY BE CHANGED BY ONE OR A COMBINATION OF THE FOLLOWING METHODS: (A) BY CHANGING THE PRINT MOTOR, (B) BY CHANGING THE EXTERNAL INTERMEDIATE DRIVE GEARS, AND (C) BY CHANGING THE POSITION OF THE GEAR AND PINION ASSEMBLY WITHIN THE GEARBOX.

As shown in Table 3.10, fifteen different print frequencies varying from 1 second/point to 150 seconds/point are obtainable with the mechanically-controlled, two-speed gearbox.

CAUTION: A considerable change in print frequency may also require a change in the full-scale balance (servo) response time. As a general rule, the interval of time between print-outs should not be less than 1-1/2 times the full-scale response time. Conversely, the full-scale response time should not be more than 2/3 of the print frequency (the latter being expressed as the time between print-outs). Refer to subject entitled "Changing Full-Scale Response Time." Likewise, a change in print frequency may require a change in the chart speed. Refer to Table 3.3 in SECTION II (Operation) of PART 3 for the recommended minimum chart speeds.

Refer to Table 3.10 and select the required components for the desired print-frequency change.

Changing Print Motor: If the print motor is being changed, proceed as follows:

(1) Disconnect blue, black, and red motor leads from terminals 1, 2, and 3 respectively on terminal block TB303.

(2) Remove the driving gear from motor shaft.

(3) Remove motor mounting screws and remove motor.

(4) Install new motor with motor mounting screws. Replace original driving gear on motor shaft (hub out) so that gear mesh between driven and driving gears is properly centered. Secure driving gear in position.

TABLE 3.10. COMPONENT PARTS FOR VARIOUS PRINT FREQUENCIES.

*PRINT FREQUENCY SECONDS/POINT (Time Between Print-Outs)	GEAR AND PINION ASSEMBLY POSITION SHOWN IN FIG. 3.21	DRIVING GEAR			DRIVEN GEAR			PRINT MOTOR	
		PART NO.	TEETH	COLOR	PART NO.	TEETH	COLOR	PART NO.	RPM
1 (Basic)θ	Pos. "A"	50860	72	Alum.	50861	48	Alum.	‡51497-20	20
4 (4 X Basic)θ	Pos. "B"								
1.5 (Basic)	Pos. "A"	51379	60	Alum.	51379	60	Alum.		
6 (4 X Basic)	Pos. "B"								
3 (Basic)	Pos. "A"	51378	40	Black	51377	80	Black		
12 (4 X Basic)	Pos. "B"								
3.75 (Basic)	Pos. "A"	51479	34	Blue	51480	85	Blue		
15 (4 X Basic)	Pos. "B"								
6 (Basic)	Pos. "A"	51375	20	Copper	51376	80	Copper		
24 (4 X Basic)	Pos. "B"								
7.5 (Basic)	Pos. "A"	51489	20	Plain	51478	100	Black		
30 (4 X Basic)	Pos. "B"								
6 (Basic)	Pos. "A"	51381	55	Blue	51380	44	Blue	‡51497-4	4
24 (4 X Basic)	Pos. "B"								
7.5 (Basic)	Pos. "A"	51379	60	Alum.	51379	60	Alum.		
30 (4 X Basic)	Pos. "B"								
15 (Basic)	Pos. "A"	51378	40	Black	51377	80	Black		
60 (4 X Basic)	Pos. "B"								
30 (Basic)	Pos. "A"	51375	20	Copper	51376	80	Copper		
120 (4 X Basic)	Pos. "B"								
37.5 (Basic)	Pos. "A"	51489	20	Plain	51478	100	Black		
150 (4 X Basic)	Pos. "B"								

*Print Frequency of Instrument (as equipped at the Factory) is specified on the DATA SHEET.
‡20 RPM Motor is supplied as standard for Basic Print Rates of 1.5, 3, 3.75, 6, and 7.5 Seconds/Point.
‡4 RPM Motor is supplied as standard for Basic Print Rates of 15, 30, and 37.5 Seconds/Point. The 4 RPM Motor may also be alternately supplied for Basic Print Rates of 6 and 7.5 Seconds/Point.
θObtainable only when Balance Motor #54040-1 is used.

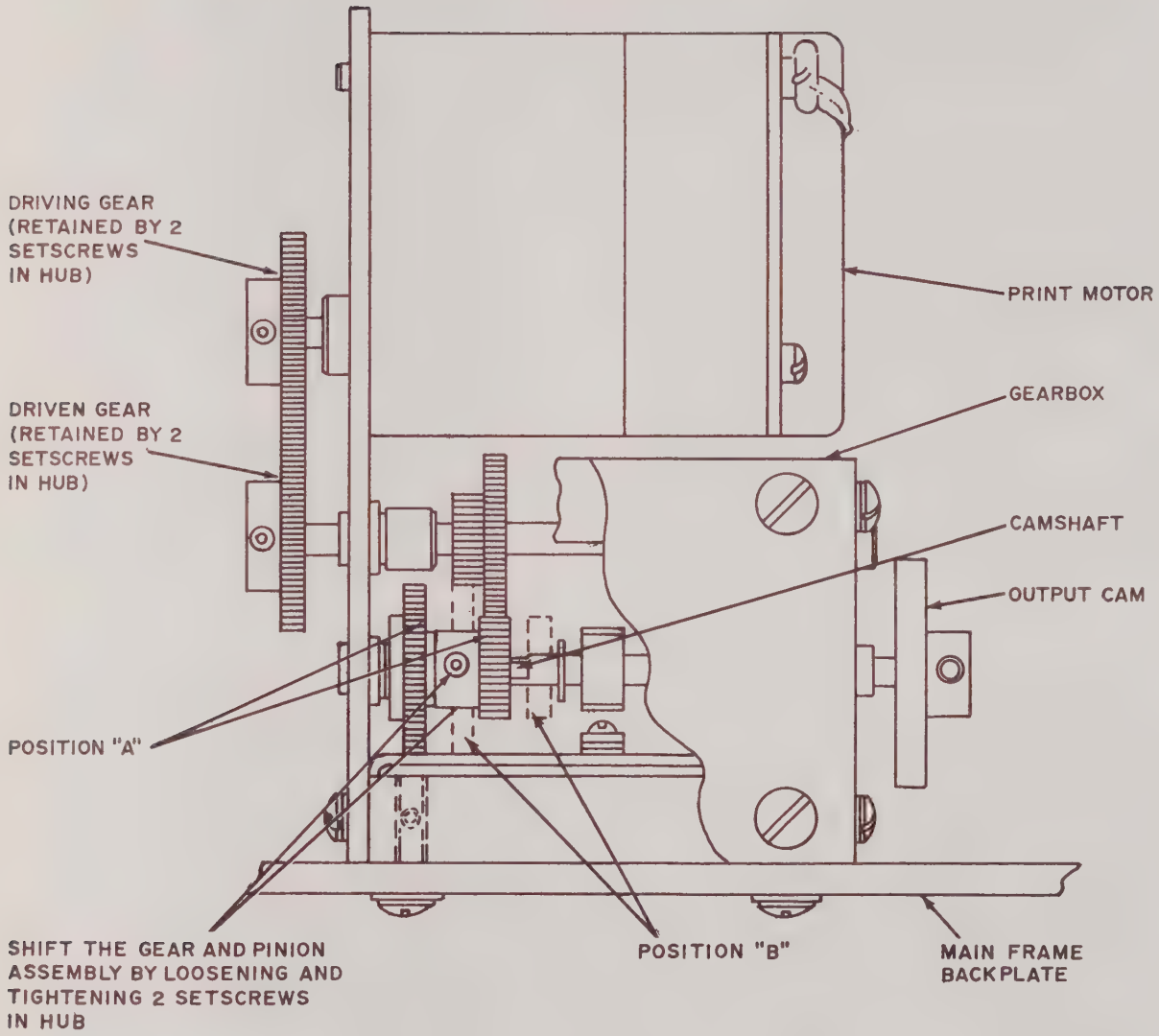

DRIVING GEAR (RETAINED BY 2 SETSCREWS IN HUB)
DRIVEN GEAR (RETAINED BY 2 SETSCREWS IN HUB)
PRINT MOTOR
GEARBOX
CAMSHAFT
OUTPUT CAM
POSITION "A"
SHIFT THE GEAR AND PINION ASSEMBLY BY LOOSENING AND TIGHTENING 2 SETSCREWS IN HUB
POSITION "B"
MAIN FRAME BACKPLATE

FIGURE 3.21. COMPONENTS INVOLVED IN CHANGING OF PRINT FREQUENCY.

(5) Connect blue, black, and red motor leads to terminals 1, 2, and 3 respectively on terminal block TB303.

Changing Intermediate Gears: The driving gear is mounted on the print motor shaft, and the driven gear is mounted on the input shaft of the gearbox. The setscrews used to secure these gears to their respective shafts are sealed at the factory with "Glyptal." The setscrews will usually only require a slight additional torque before they will break loose. In case of difficulty, use small amount of acetone or other suitable solvent to soften the "Gyptal." The setscrews of a newly installed gear should again be sealed with "Glyptal" or an equivalent cement.

Change the intermediate gears as follows:

(1) Remove original driving and driven gears from their respective shafts.

(2) Install new gears on their respective shafts (hubs out) so that gear mesh between driven and driving gears is properly centered. Secure gears in position.

Shifting Position of Gear and Pinion Assembly in Gearbox (Refer to Figure 3.21): Refer to Table 3.10 for the desired print-frequency selection with respect to a particular set of intermediate drive gears. Change speed selection as follows:

(A) Remove four screws from gearbox cover. Remove cover.

(B) Use hex (Allen) wrench and loosen two setscrews in the gear and pinion assembly.

(C) Slide gear and pinion assembly to following positions:

Fast-speed ratio--See position "A" in Figure 3.21.
Slow-speed ratio--See position "B" in Figure 3.21.

After selecting the desired speed, retighten the two setscrews against the flats in cam shaft. Seal setscrews with "Glyptal" or an equivalent cement.

(D) Replace cover and secure with four mounting screws.

NOTE: For changing the print frequency on recorders optionally equipped with programmed printing or dual print frequency, refer to appropriate instruction supplement found in the APPENDIX, PART 6.

CHANGING FULL-SCALE RESPONSE TIME

The full-scale response speed (expressed in seconds) is a measure of the time interval that it takes the printhead to fully move from one end of the scale to the other. This time interval is determined by the balance (servo) motor, the motor pinion, and the bullgear. Various combinations of these components used to establish the different full-scale response speeds are shown in Table 3.11.

CAUTION: It should be remembered that the full-scale response time must be compatible with the print frequency (the latter being expressed as the time interval between print-outs). As a general rule, the full-scale response time should not be more than 2/3 of the print frequency. Conversely, the time interval between print-outs should not be less than 1-1/2 times the full-scale response time. Therefore, the response speed and the print frequency should both be considered before changing the full-scale response speed. Refer to subject entitled "Changing Print Frequency" for procedures involving a print-frequency change.

Refer to Table 3.11 and select the required components for the desired full-scale response speed. The complete procedure for changing the full-scale response time is as follows:

(1) Swing out chart drive frame.

(2) Remove pinion from balance (servo) motor shaft.

TABLE 3.11. COMPONENT PARTS FOR VARIOUS FULL-SCALE RESPONSE SPEEDS.

RESPONSE SPEED	MOTOR		PINION		BULLGEAR (WITH INTEGRAL SLIP-CLUTCH MECHANISM)		ANTI-BACKLASH GEAR		SPRING	
(SECONDS)	PART NO.†	RPM	PART NO.	TEETH	PART NO.	TEETH	PART NO.	TEETH	PART NO.	QTY.
1/2	54040-1 OR 51114	1200	54386	36	*54375	324	*54377	324	*6336	2
1	54041-1 OR 51671	120	54101	108	54276-B	252				
4	54041-1 OR 51671	120	54104	36	54375	324				
15	54042	7	54102	128	54277-B	232				
20	54042	7	54101	108	54276-B	252				
30	54042	7	54103	80	54278-B	280				

*Assembly No. 54375-1 †See Instrument Data Sheet for Motor Supplied.

(3) If changeover requires a replacement of the balance (servo) motor, proceed as follows:

(a) Disconnect black, blue, white, yellow, and red motor leads from terminals 5, 6, 7, 8, and 9 respectively on terminal block TB401.

(b) Remove motor mounting screws and remove motor.

(4) Refer to Figure 3.21-1 and disassemble the servo gear-grain components in the sequence shown.

(5) Install new bullgear and then reassemble the servo gear-train components as shown in Figure 3.21-1.

(6) If required, install new balance (servo) motor as follows:

(a) Mount motor with mounting screws.

(b) Connect black, blue, white, yellow, and red motor leads to terminals 5, 6, 7, 8, and 9 respectively on terminal block TB401.

(7) Install new pinion on motor shaft so that mesh between pinion and bullgear is properly centered.

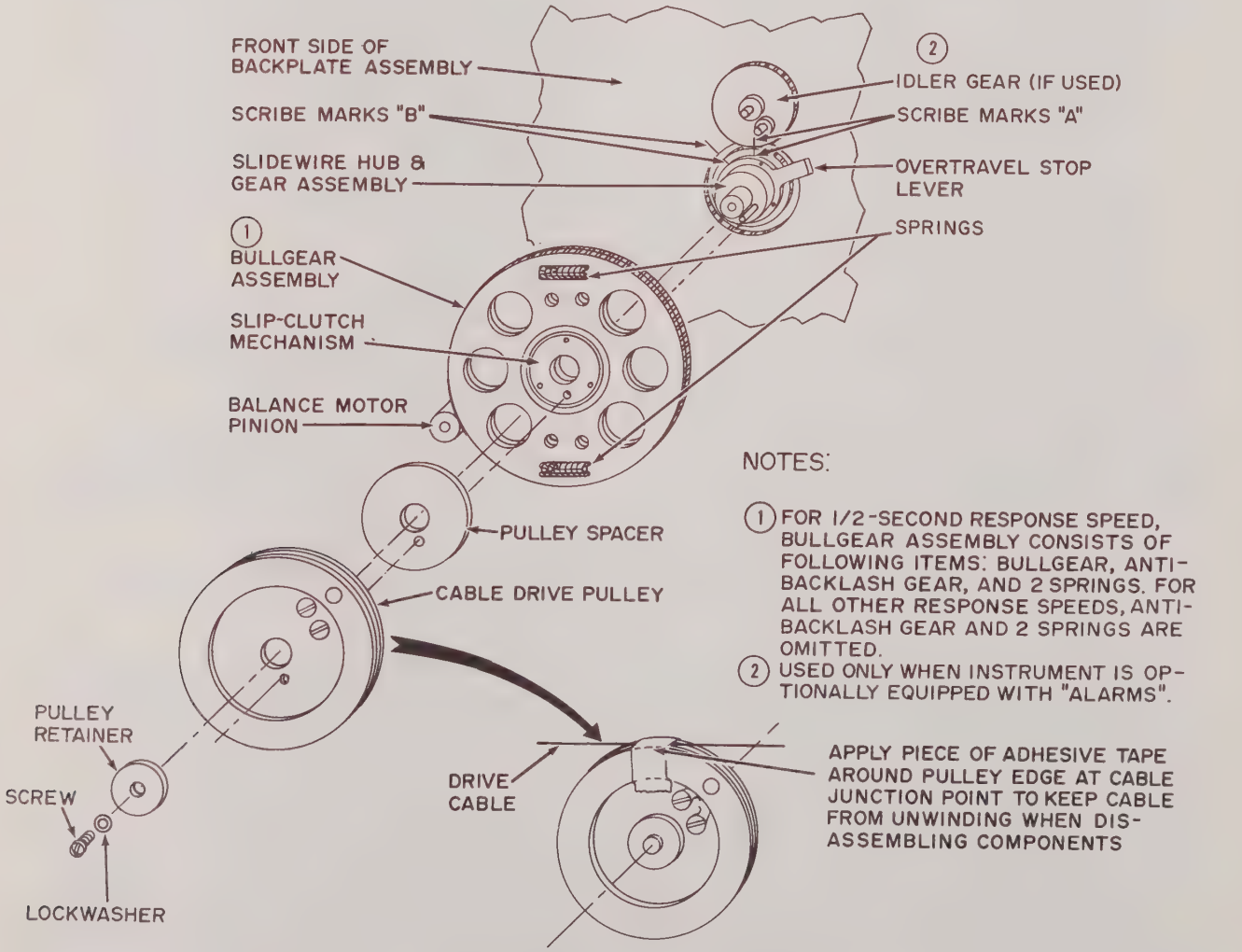

FRONT SIDE OF BACKPLATE ASSEMBLY
SCRIBE MARKS "B"
SLIDEWIRE HUB & GEAR ASSEMBLY
(1) BULLGEAR ASSEMBLY
SLIP-CLUTCH MECHANISM
BALANCE MOTOR PINION
PULLEY SPACER
CABLE DRIVE PULLEY
PULLEY RETAINER
SCREW
LOCKWASHER
DRIVE CABLE
(2) IDLER GEAR (IF USED)
SCRIBE MARKS "A"
OVERTRAVEL STOP LEVER
SPRINGS
NOTES:
(1) FOR 1/2-SECOND RESPONSE SPEED, BULLGEAR ASSEMBLY CONSISTS OF FOLLOWING ITEMS: BULLGEAR, ANTI-BACKLASH GEAR, AND 2 SPRINGS. FOR ALL OTHER RESPONSE SPEEDS, ANTI-BACKLASH GEAR AND 2 SPRINGS ARE OMITTED.
(2) USED ONLY WHEN INSTRUMENT IS OPTIONALLY EQUIPPED WITH "ALARMS".
APPLY PIECE OF ADHESIVE TAPE AROUND PULLEY EDGE AT CABLE JUNCTION POINT TO KEEP CABLE FROM UNWINDING WHEN DISASSEMBLING COMPONENTS

FIGURE 3.21-1. RELATIONSHIP OF SERVO GEAR-TRAIN COMPONENTS.

(8) Adjust position of motor for minimum backlash with no binding. To reduce backlash, turn motor to left and upward. To increase backlash, turn motor to right and upward.

INTERCHANGING MULTICOLOR AND UNICOLOR INK WHEELS

If a unicolor ink wheel is replaced with a multicolor ink wheel, it will be necessary to mechanically synchronize the multicolor ink wheel with the print wheel so that the proper colors are printed out for the various number-of-points (-stations) selected. Part numbers for the various multicolor ink wheel assemblies are listed in the "ILLUSTRATED PARTS BREAKDOWN," SECTION II of PART 4. Refer to topic heading entitled "Replacing Multicolor Ink Wheel" for proper installation procedures.

If a multicolor ink wheel is replaced with a unicolor ink wheel, no special mechanical synchronization procedures need to be performed since the same color is printed for all points (stations). Part numbers for the various unicolor ink wheel assemblies are listed in the "ILLUSTRATED PARTS BREAKDOWN," SECTION II of PART 4. Install unicolor ink wheel as follows:

(1) Remove multicolor ink wheel and replace with a unicolor ink wheel.

(2) To ink the print wheel, turn the point (station) advance control two or three revolutions in the counterclockwise direction.

(3) Turn on instrument and check for satisfactory printing. If the printing is either too light or too heavy, adjust the tension of the printhead impact spring as described under the MECHANICAL SERVICE ADJUSTMENTS instructions.

Electrical Maintenance

GENERAL

The following instructions deal primarily with service maintenance on the electrical assemblies and components of the multipoint recorder. Refer to the previous section for mechanical maintenance, and to PART 2, SECTION III of this manual for chart drive maintenance procedures.

Periodic electrical maintenance schedules should be established and followed to insure trouble-free operation. These schedules should include a general inspection of all wiring connections, a check of adjustments, a damping and deadband test, and a calibration check. If trouble is detected, refer to the following field service procedures. Contact your nearest authorized Esterline Angus representative for additional factory service.

WARNING: To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

TEST EQUIPMENT

Instruments required for troubleshooting the electrical systems of the recorder are as follows:

A commercial grade VTVM or multimeter is recommended for the measurement of all DC voltages and resistances. The multimeter should have a DC sensitivity of 20,000 ohms-per-volt. An AC VTVM is recommended for setting filter adjustments and for the measurements of low-level AC signals.

A precision-grade portable potentiometer is recommended as a test signal source. A known test signal is useful in checking instrument accuracy, linearity, and calibration. The potentiometer must have a variable DC output within the measurement range of the recorder and a dial calibration accuracy of $\pm 0.1\%$.

Although not essential in performing the recommended troubleshooting procedures, an oscilloscope may be of value in detecting noise signals or measuring power supply ripple. Any commercially available oscilloscope having a good DC-to 1000-cycle response and amplitude calibration provisions should be suitable for this application.

A power-line signal source will be needed for adjustment of the input filter. An isolation type, line to 24-volt, step-down transformer is recommended for this test procedure.

ELECTRICAL SERVICE ADJUSTMENTS

Recorder service adjustments consist of the SPAN control (R111), COMP control (R112), ZERO control (R235), two filter adjust controls (R205, R210), and the bias level control (R246). GAIN, DAMPING, and THRESHOLD adjustments are operator controls and are completely described in PART 3 SECTION II (Operation) of this manual.

The ZERO control is accessible from the front of the amplifier as shown in Figure 3.22. The SPAN and COMP controls are accessible from the top of the reference voltage supply as shown in Figure 3.22-1.

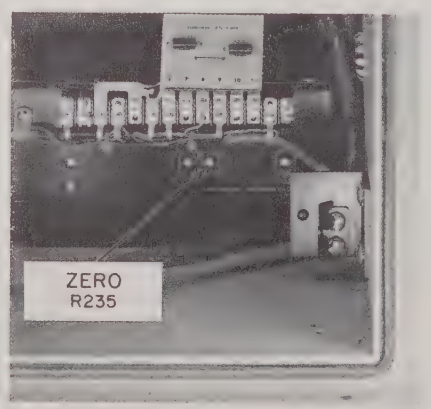


FIGURE 3.22. AMPLIFIER SERVICE ADJUSTMENTS.

THE TWO FILTER ADJUST CONTROLS (R205, R210) AND THE BIAS LEVEL CONTROL (R246) ARE NOT ACCESSIBLE FROM THE FRONT OF THE AMPLIFIER. TO GAIN ACCESS TO THESE CONTROLS, IT IS NECESSARY TO FIRST REMOVE THE AMPLIFIER; THEN, ACCESS TO THE CONTROLS MAY BE OBTAINED BY REMOVING THE AMPLIFIER TOP COVER. LOCATION OF THESE CONTROLS IS SHOWN IN FIGURE 3.25. INSTRUCTIONS FOR REMOVING THE AMPLIFIER ARE GIVEN UNDER SUBJECT HEADING "COMPONENTS REPLACEMENT" IN THIS SECTION OF THE MANUAL.

ALL OF THE SERVICE ADJUSTMENTS ARE PRESET AT THE FACTORY AND SHOULD NOT NORMALLY REQUIRE OPERATOR ATTENTION IN THE FIELD.

SPAN, COMP, AND ZERO CONTROLS

THE SPAN (R111), COMP (R112), AND ZERO (R235) CONTROLS ARE USED TO PRECISELY CALIBRATE THE MEASURING SPAN OF THE INSTRUMENT. THE ADJUSTMENT PROCEDURE OF THESE CONTROLS ARE MORE FULLY DESCRIBED UNDER "RECORDER CALIBRATION." A FUNCTIONAL DESCRIPTION OF EACH CONTROL FOLLOWS:

CAUTION: ONLY QUALIFIED PERSONNEL HAVING ACCESS TO ACCURATE SIGNAL STANDARDS SHOULD ATTEMPT ADJUSTMENT OF THESE CONTROLS.

SPAN CONTROL (R111, FIGURE 3.22-1): THIS IS A SCREWDRIVER ADJUSTMENT ACCESSIBLE THROUGH A HOLE IN TOP OF THE REFERENCE SUPPLY COVER. THE CONTROL SERVES TO REGULATE THE AMOUNT OF DC REFERENCE VOLTAGE APPLIED TO THE SLIDEWIRE LEG OF THE BRIDGE-CONFIGURATED, MEASURING CIRCUIT. THE SPAN CONTROL SETTING DETERMINES THE ACCURACY OF FULL-SPAN CALIBRATION. A SPAN ADJUSTMENT WILL USUALLY HAVE SOME INTERACTION WITH THE ZERO ADJUSTMENT, ESPECIALLY WHEN INSTRUMENT ZERO IS ELEVATED OR SUPPRESSED.

COMP CONTROL (R112, FIGURE 3.22-1): THE COMP CONTROL IS ALSO A SCREWDRIVER ADJUSTMENT WHICH IS ACCESSIBLE THROUGH A HOLE ADJACENT TO THE SPAN ADJUSTMENT. THIS CONTROL ADJUSTS THE VALUE OF DC REFERENCE VOLTAGE WHICH IS APPLIED TO THE RANGE CARD AND ZERO CONTROL LEG OF THE BRIDGE-CONFIGURATED, MEASURING CIRCUIT. THE COMP CONTROL MUST BE PRECISELY SET IN ORDER TO OBTAIN THE SPAN LIMITS OF THE VARIOUS MEASURING RANGES. A SMALL INTERACTION MAY EXIST BETWEEN THE COMP AND SPAN ADJUSTMENTS.

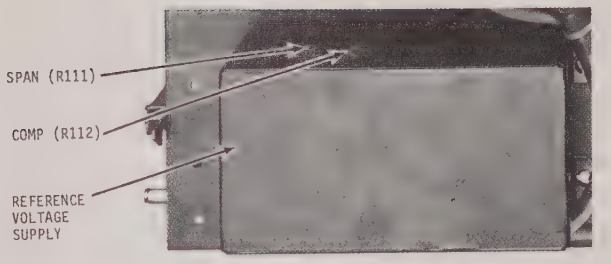


FIGURE 3.22-1. REFERENCE VOLTAGE SUPPLY SERVICE ADJUSTMENTS.

ZERO CONTROL (R235): THE ZERO CONTROL IS A SEPARATE SCREWDRIVER ADJUSTMENT CLEARLY LABELED ON THE FRONT OF THE AMPLIFIER. IT IS NOT MERELY AN INPUT ZERO CONTROL BUT ACTUALLY AN ADJUSTMENT PROVISION FOR CALIBRATING THE LOWER END OF THE MEASUREMENT SPAN. THE SETTING OF THIS CONTROL MAY NOT HAVE A DIRECT RELATION TO ZERO SIGNAL INPUTS OR TO A ZERO MARKING ON THE SCALEPLATE. ON ZERO-BASED MILLIVOLT INSTRUMENTS, HOWEVER, SCALE ZERO WILL USUALLY REPRESENT ZERO SIGNAL INPUTS; AND THE CONTROL MAY BE SET FOR A ZERO REFERENCE POINT.

NORMALLY, THE ZERO CONTROL SHOULD BE ADJUSTED ONLY WHEN CALIBRATING THE INSTRUMENT USING AN ACCURATE SIGNAL SOURCE. IN SOME INSTANCES, HOWEVER, ESPECIALLY WHEN THE INSTRUMENT HAS HAD A RECENT CALIBRATION, THE ZERO CONTROL MAY BE "TOUCHED UP" WITHOUT RECHECKING COMPLETE CALIBRATION. THIS APPLIES PARTICULARLY TO INSTRUMENTS IN WHICH ZERO (LEFT END) OF THE SCALE OR SPAN REPRESENTS ZERO OF THE MEASURED VARIABLE. IN SUCH INSTRUMENTS ZERO MAY BE CHECKED BY SHORTING THE SIGNAL INPUT TERMINALS AT THE SIGNAL INPUT PANEL. THIS IS NOT APPLICABLE, HOWEVER, TO INSTRUMENTS IN WHICH THE ZERO HAS BEEN SUPPRESSED OR ELEVATED. IF ZERO OF THE INPUT VARIABLE FALLS AT OR NEAR THE LOWER END OF THE SCALE, ZERO AND SPAN ADJUSTMENTS WILL HAVE MINIMUM INTERACTION. WITH A SUPPRESSED OR ELEVATED ZERO, HOWEVER, CONSIDERABLE INTERACTION IS LIKELY.

WITH THERMOCOUPLE INPUTS, IT SHOULD BE REMEMBERED THAT THE INSTRUMENT MUST READ REFERENCE JUNCTION TEMPERATURE (IF ON SCALE) WHEN THE INPUT TERMINALS ARE SHORTED AT THE SIGNAL INPUT PANEL. SHORTING THE INPUT TERMINALS DOES NOT REPRESENT ZERO INPUT TO THE MEASURING CIRCUIT IN THIS CASE BECAUSE THE AUTOMATIC REFERENCE JUNCTION COMPENSATOR HAS A CONTINUOUS OUTPUT PROPORTIONAL TO THE AMBIENT TEMPERATURE OF THE INPUT TERMINALS.

FILTER ADJUST CONTROLS (R205, R210)

THESE TWO CONTROLS ARE CONNECTED INTO THE INPUT FILTER CIRCUIT. THEY HAVE BEEN ADJUSTED AT THE FACTORY FOR MAXIMUM REJECTION OF POWER-LINE FREQUENCIES AND SHOULD RARELY REQUIRE ATTENTION IN THE FIELD. HOWEVER, IF A COMPONENT IN THE ASSOCIATED CIRCUITRY HAS BEEN REPLACED, OR IF IT IS DESIRED TO CHECK THE FILTER ADJUSTMENT--PROCEED AS FOLLOWS:

NOTE: REFER TO FIGURE 3.25 FOR THE LOCATION OF FILTER CONTROLS (R205, R210) AND TEST POINT (TP201).

(1) REMOVE AMPLIFIER TO A SERVICEABLE POSITION AS DESCRIBED UNDER TOPIC HEADING "AMPLIFIER SERVICING" IN THIS SECTION OF THE MANUAL.

(2) REMOVE ALL CONNECTIONS FROM TERMINAL 3 OF TB201.

(3) CONNECT THE SECONDARY OF A 120- TO 24-VOLT STEPDOWN, TRANSFORMER TO TERMINALS 3 AND 4 OF TB201 AS SHOWN IN FIGURE 3.23A.

(4) CONNECT RC NETWORK AND AC VTVM AS SHOWN IN FIGURE 3.23B. CONNECT A JUMPER BETWEEN TERMINALS 1 AND 4 OF TB201.

(5) ALTERNATELY, ADJUST THE TWO FILTER CONTROLS (R205 AND R210) FOR A MINIMUM READING ON VTVM. REDUCE RANGE OF METER AS REQUIRED. REPEAT UNTIL ABSOLUTE MINIMUM READING IS OBTAINED.

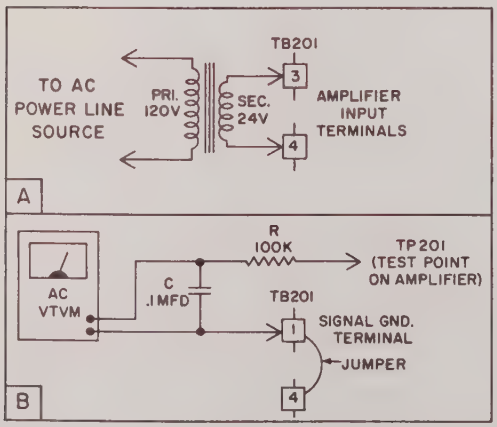


FIGURE 3.23. TEST CONNECTION DIAGRAMS FOR INPUT FILTER ADJUSTMENT.

NOTE: IT IS NOT NECESSARY TO HAVE POWER APPLIED TO THE INSTRUMENT DURING THE ADJUSTMENT OF THE FILTER CONTROLS.

(6) DISCONNECT TEST EQUIPMENT, REINSTALL AMPLIFIER, RESTORE CONNECTIONS TO TB201, AND CHECK OPERATION.

BIAS LEVEL CONTROL (R246)

THE BIAS LEVEL CONTROL IS A SERVICE ADJUSTMENT EMPLOYED IN THE EMITTER FOLLOWER CIRCUIT OF Q202. AN ADJUSTABLE PORTION OF THE VOLTAGE DEVELOPED ACROSS THIS CONTROL SETS THE DC OPERATING BIAS VOLTAGE FOR THE PREAMPLIFIER STAGE OF Q201. THE ADJUSTMENT OF THIS CONTROL IS SET AT THE FACTORY AND SHOULD NOT REQUIRE READJUSTMENT IN THE FIELD. HOWEVER, IF ANY OF THE COMPONENTS IN THE ASSOCIATED CIRCUITRY OF STAGES Q201 AND/OR Q202 HAVE BEEN REPLACED, OR IF IT IS DESIRED TO CHECK THE BIAS LEVEL ADJUSTMENT--PROCEED AS FOLLOWS:

NOTE: REFER TO FIGURE 3.25 FOR THE LOCATION OF BIAS LEVEL CONTROL (R246) AND TEST POINT (TP205).

(1) REMOVE AMPLIFIER TO A SERVICEABLE POSITION AS DESCRIBED UNDER TOPIC HEADING "AMPLIFIER SERVICING" IN THIS SECTION OF THE MANUAL.

(2) REMOVE ALL CONNECTIONS FROM TERMINAL 3 OF TB201. CONNECT A JUMPER BETWEEN TERMINALS 1 AND 3 OF TB201.

(3) TURN POWER SWITCH ON AND LEAVE CHART DRIVE SWITCH TURNED OFF.

(4) SELECT 0-10V RANGE ON VOM. CONNECT POSITIVE (+) LEAD OF VOLTMETER TO TP205 AND NEGATIVE (-) LEAD TO AMPLIFIER FLOATING (▽) OR CHASSIS (⏚) GROUND.

(5) ADJUST BIAS LEVEL CONTROL (R246) FOR A 4.5V READING ON VOLTMETER.

(6) REMOVE VOLTMETER CONNECTIONS FROM PRINTED CIRCUIT BOARD. REMOVE JUMPER FROM TERMINALS 1 AND 3 OF TB201.

(7) REINSTALL AMPLIFIER, RESTORE CONNECTIONS TO TB201, AND CHECK OPERATION.

RECORDER CALIBRATION

All multipoint recorders are precisely aligned and calibrated before leaving the factory and will not normally require recalibration in the field. However, if the range has been changed or corrective maintenance has been performed, instrument calibration should always be checked. If calibration is not within the desired accuracy, a thorough troubleshooting check should be made before attempting any calibration procedures. Calibration errors are often caused by excessive interference or mechanical friction, a poor connection, a faulty range card, or by a defective slidewire, amplifier, or reference supply. See the troubleshooting guides in Tables 3.7 and 3.13.

Recorder calibration may be checked by a direct comparison with a known-accurate standard. The validity of such a test, however, depends upon the accuracy of the standard source--which, of course, should be considerably better than accuracy requirements of the recorder.

It is recommended that only a qualified person having access to a precision signal source proceed with the following calibration procedures.

A. Pre-Calibration Steps

Perform the following steps before proceeding with the voltage or thermocouple calibration procedures:

(1) Check mechanical alignment. Refer to "Mechanical Calibration Adjustments" under the MECHANICAL SERVICE ADJUSTMENTS instructions.

(2) See that the correct chart and range card are properly installed. The part number of the chart, type of signal input actuation, type of thermocouple (if input is thermocouple-actuated), and measuring range of your instrument are specified on the instrument DATA SHEET.

(3) Turn on POWER switch and allow 10 minutes for instrument to warm up; then turn on CHART DRIVE switch.

(4) Adjust operator controls for a desired response with minimum deadband. Refer to "Operator Control Adjustment Procedures" in SECTION II of PART 3.

B. Voltage (Millivolts, Volts) Calibration Procedures

(1) Turn off print motor.

(2) If instrument is prewired at factory for a number-of-point selection less than 24 points, proceed as follows:

(a) If the optional number-of-points socket is plugged into input panel, unplug socket from panel.

(b) If input panel is wired for a fixed number-of-points less than 24 (no points socket used), check and remove any signal input leads from any of the point terminals that are internally wired in parallel with point terminals No. 1. Points that are internally wired in parallel can be determined by referring to Table 3.9.

(3) Turn off print motor and disconnect any signal input leads which may be occupying point (station) terminals number 1 on signal input panel TB501.

(4) Connect output of reference potentiometer to point (station) terminals number 1 on input panel TB501. Use copper wire and observe proper polarity. See Figure 3.23-1. Use a precision-grade reference potentiometer as the test signal source. The potentiometer must have a variable DC output to cover the measuring range of the recorder and a dial calibration accuracy of ±0.1%. Standardize potentiometer as required.

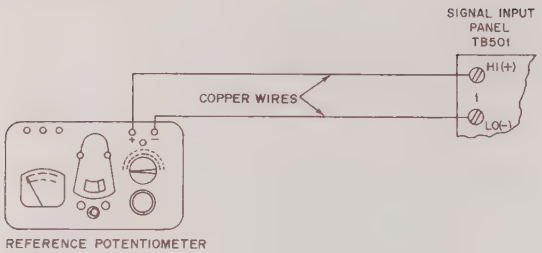


FIGURE 3.23-1. VOLTAGE (MILLIVOLTS, VOLTS) CALIBRATION CONNECTION DIAGRAM.

(5) To position the selector switch on point No. 1, rotate the point (station) advance control in the direction of the arrow until the point preceeding No. 1 appears in the scaleplate window. Turn on the print motor and when the system advances to point No. 1, turn off the motor making sure that the system comes to rest with the printhead in its raised position and the signal-cutoff switch open.

NOTE: Vary the source signal; if the servo responds to the variations, the selector and signal-cutoff switches are in their correct positions.

(6) To keep the selector switch from advancing, lift the switch actuating pawl from the switch ratchet and secure in a raised position.

NOTE: For convenience, place a strip of tape under the pawl with ends adhering to the top of the gearbox and switch housings.

(7) Select 0-10V range on multimeter. Connect positive (+) and negative (-) leads of meter across terminals 6 and 9 respectively of terminal block TB201. Adjust COMP control (Figure 3.22-1) for 6.5-volt reading on meter. Remove meter connections.

(8) Determine the input span of the instrument's measurement range (see instrument DATA SHEET).

(9) Set input value of reference potentiometer to 0% value of the input span. This value will be zero for a zero-based measurement range (for example, 0MV to 100MV). However, for a zero-suppressed range (for example, 10MV to 100MV), this value will be 10MV; and for a zero-elevated range (for example, -5MV to +5MV) this value will be -5MV.

(10) The servo should respond to the calibration signal and balance at the input signal level on the span.

(11) Leaving the print motor off, rotate the gearbox output cam until the cam follower springs into the notch on the cam. This will cause the printhead to drop and the point value to be printed out on the chart.

CAUTION: If the print motor is a 4-RPM unit and no overrunning clutches are employed in the gearbox, it will be necessary to disengage one of the external intermediate drive gears on the input side of the gearbox before the output cam can be manually turned.

(12) Continue to rotate the gearbox output cam until the printhead rises and the signal-cutoff switch opens. Observe the value indicated on the chart.

(13) If the low-end calibration is not satisfactory, carefully adjust the ZERO control (Figure 3.22) until the correct value is obtained. Repeat Steps 11 and 12 as required.

(14) Set input value of reference potentiometer to 100% value of the input span. Repeat Steps 10, 11, and 12.

(15) If full-scale calibration is not satisfactory, carefully adjust the SPAN control (Figure 3.22-1) until the correct value is obtained. Repeat Steps 11 and 12 as required.

NOTE: DURING THE CALIBRATION PROCEDURES, IT MAY BE NOTICED THAT AFTER SEVERAL PRINT-OUTS (USUALLY ABOUT 3 OR 4) OF POINT (STATION) NUMBER 1, THE RECORDED DOT WILL BECOME FAINT OR MAY ENTIRELY DISAPPEAR DUE TO LACK OF INK ON THE PRINT WHEEL FOR POINT NUMBER 1. IN THIS CASE, TURN THE MANUAL POINT (STATION) ADVANCE CONTROL ONE OR TWO REVOLUTIONS IN THE COUNTER-CLOCKWISE DIRECTION SO THAT PRINT WHEEL BECOMES REINKED. CONTINUE TO TURN ADVANCE CONTROL UNTIL POINT NO. 1 REAPPEARS IN THE SCALEPLATE WINDOW. THEN CONTINUE WITH CALIBRATION PROCEDURES AS SPECIFIED.

(16) IF A SPAN ADJUSTMENT IS PERFORMED, RECHECK THE LOW-END CALIBRATION AND READJUST THE ZERO CONTROL IF NECESSARY. SINCE ZERO AND SPAN CONTROLS MAY HAVE SOME INTERACTION, REPEAT THE ADJUSTMENT OF EACH UNTIL CALIBRATION IS ACCEPTABLE AT BOTH ENDS OF THE SPAN.

(17) SET INPUT VALUES OF REFERENCE POTENTIOMETER TO 0, 25, 50, 75, AND 100% VALUES OF THE INPUT SPAN AND CHECK RECORDED VALUES AT 0, 25, 50, 75, AND 100% OF CHART SPAN. RECORDED VALUES SHOULD BE WITHIN $\pm$0.25% OF CHART SPAN. IF NON-LINEARITY EXCEEDS CALIBRATION TOLERANCE, TROUBLE-SHOOT THE RECORDER; LOOK FOR EXCESSIVE MECHANICAL FRICTION OR A DEFECTIVE SLIDEWIRE.

NOTE: CONSIDERABLE INTERACTION OF ZERO AND SPAN ADJUSTMENTS MAY BE ENCOUNTERED ON RANGES HAVING A SUPPRESSED OR ELEVATED ZERO. IT IS RECOMMENDED IN THESE CASES THAT CALIBRATION BE APPROACHED AT BOTH ENDS OF THE SPAN BY CORRECTING FOR ONLY ONE HALF THE ACTUAL ERROR EACH TIME EITHER CONTROL IS ADJUSTED. IN SOME CASES, THE SPAN CONTROL MAY HAVE MORE EFFECT AT THE LOW END OF THE SPAN, WHILE THE ZERO CONTROL MAY HAVE MORE EFFECT AT THE HIGH END.

(18) THE CALIBRATION MAY BE PERFORMED FOR ANY OTHER POINTS (STATIONS) ON THE INPUT PANEL BY FOLLOWING THE PROCEDURES GIVEN FOR POINT NUMBER 1 IN STEPS 1 THROUGH 17 ABOVE. IF THE CALIBRATION RESULTS ARE NOT THE SAME FOR ALL POINTS, TROUBLESHOOT THE INPUT CIRCUITRY BEFORE ATTEMPTING RE-CALIBRATION.

(19) REMOVE CALIBRATION CONNECTIONS FROM INPUT PANEL AND RECONNECT ORIGINAL SIGNAL INPUT CONNECTIONS TO THEIR RESPECTIVE POINT TERMINALS ON PANEL. REINSERT (IF ORIGINALLY REMOVED IN STEP 2 ABOVE) NUMBER-OF-POINTS (-STATIONS) SOCKET IN PANEL. ALLOW SWITCH ACTUATING PAWL TO ENGAGE SELECTOR SWITCH RATCHET IN THE NORMAL MANNER. TURN ON PRINT MOTOR AND RESUME NORMAL OPERATION.

C. THERMOCOUPLE CALIBRATION PROCEDURES

THE PROCEDURES FOR CALIBRATING THERMOCOUPLE-ACTUATED MEASURING RANGES ARE ESSENTIALLY THE SAME AS THE "VOLTAGE CALIBRATION PROCEDURES" GIVEN ABOVE. PROCEED AS FOLLOWS:

NOTE: A TYPICAL EXAMPLE OF SETUP PROCEDURES APPLICABLE TO THERMOCOUPLE CALIBRATION IS SHOWN IN TABLE 3.12.

(1) PERFORM STEPS 1 THROUGH 3 UNDER "VOLTAGE CALIBRATION PROCEDURES".

(2) MAKE CALIBRATION CONNECTIONS TO POINT TERMINALS NUMBER 1 ON INPUT PANEL AS SHOWN IN FIGURE 3.23-2.

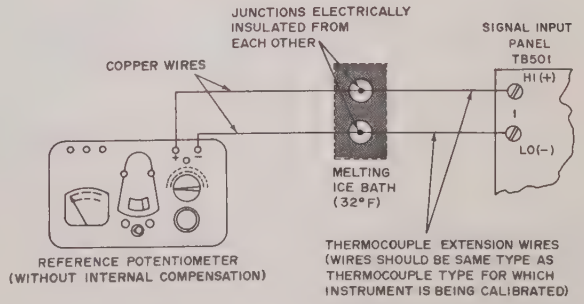

JUNCTIONS ELECTRICALLY INSULATED FROM EACH OTHER
SIGNAL INPUT PANEL TB501
COPPER WIRES
HI(+)
LO(-)
MELTING ICE BATH (32°F)
REFERENCE POTENTIOMETER (WITHOUT INTERNAL COMPENSATION)
THERMOCOUPLE EXTENSION WIRES (WIRES SHOULD BE SAME TYPE AS THERMOCOUPLE TYPE FOR WHICH INSTRUMENT IS BEING CALIBRATED)

FIGURE 3.23-2. THERMOCOUPLE CALIBRATION CONNECTION DIAGRAM.

TABLE 3.12. TYPICAL THERMOCOUPLE CALIBRATION EXAMPLE.

GIVEN: (1) THERMOCOUPLE TYPE: IRON-CONSTANTAN (TYPE J)
(2) MEASUREMENT RANGE: 0°-1000°F.
(3) MEASUREMENT SPAN: 1000°F.
(4) TEMPERATURE-EMF CONVERSION TABLE: USE IRON-CONSTANTAN TABLE WITH VALUES BASED ON REFERENCE JUNCTION OF 32°F. (0°C.)

CALIBRATE: CALIBRATE INSTRUMENT AT INPUTS OF 0, 25, 50, 75, AND 100% OF INPUT SPAN.

% OF INPUT SPAN	TEMPERATURE VALUE (°F.)	TEMPERATURE-EMF EQUIVALENT READ FROM TABLE (MV)	REFERENCE POTENTIOMETER SETTING (MV)
0	0°	-0.89	-0.89
25	250°	6.42	6.42
50	500°	14.12	14.12
75	750°	21.79	21.79
100	1000°	29.52	29.52

(3) PERFORM STEPS 5 THROUGH 7 UNDER "VOLTAGE CALIBRATION PROCEDURES".

(4) DETERMINE THE INPUT SPAN OF THE INSTRUMENT'S MEASUREMENT RANGE (SEE INSTRUMENT DATA SHEET).

(5) USE A TEMPERATURE-EMF CONVERSION TABLE. SELECT THE CONVERSION TABLE WITH REFERENCE JUNCTION OF 32°F (0°C) FOR THE TYPE OF THERMOCOUPLE USED.

(6) REFER TO CONVERSION TABLE AND SET REFERENCE POTENTIOMETER TO A MV VALUE THAT IS EQUIVALENT TO 0% VALUE OF THE TEMPERATURE INPUT SPAN.

(7) PERFORM STEPS 10 THROUGH 13 UNDER "VOLTAGE CALIBRATION PROCEDURES".

(8) REFER TO CONVERSION TABLE AND SET REFERENCE POTENTIOMETER TO A MV VALUE THAT IS EQUIVALENT TO 100% VALUE OF THE TEMPERATURE INPUT SPAN.

(9) PERFORM STEPS 15 AND 16 UNDER "VOLTAGE CALIBRATION PROCEDURES".

(10) REFER TO CONVERSION TABLE AND SET REFERENCE POTENTIOMETER TO MV VALUES THAT ARE EQUIVALENT TO 0, 25, 50, 75, AND 100% VALUES OF THE TEMPERATURE INPUT SPAN. CHECK RECORDED VALUES AT 0, 25, 50, 75, AND 100% OF CHART SPAN. RECORDED VALUES SHOULD BE WITHIN ±0.25% OF CHART SPAN. IF NON-LINEARITY EXCEEDS CALIBRATION TOLERANCE, TROUBLESHOOT THE RECORDER; LOOK FOR EXCESSIVE MECHANICAL FRICTION OR A DEFECTIVE SLIDEWIRE.

(11) PERFORM STEPS 18 AND 19 UNDER "VOLTAGE CALIBRATION PROCEDURES".

RANGE CHANGING

THE BASIC MULTIPOINT RECORDER MAY ACCOMMODATE A STANDARD INPUT ACTUATION OF DC VOLTS, DC MILLIVOLTS, DC CURRENT, OR THERMOCOUPLE. THE RESISTIVE COMPONENTS ON THE AMPLIFIER RANGE CARD DETERMINE THE SPECIFIC MEASUREMENT RANGE WITHIN ANY GIVEN TYPE OF ACTUATION.

NOTE: THE INSTRUMENT MAY ALSO ACCOMMODATE OTHER SPECIAL INPUT ACTUATIONS SUCH AS THE THERMISTOR BRIDGE OR DC RESISTANCE BRIDGE (WHEATSTONE BRIDGE). IN THESE APPLICATIONS, CONSULT FACTORY WHEN A RANGE CHANGE (ACTUATION CHANGE NOT POSSIBLE) IS REQUIRED.

The range of the instrument may be changed in the field quite readily by installing the required chart and the components of the desired range-change kit as shown in Figure 3.24. In some applications, it may not be required to change the chart and scale since a multiplication or dividing factor applied to the existing chart and scale may suffice.

Table 3.12-1 lists the range-change kits (by letter designation) that are required when changing the measurement actuation and/or measurement range of the recorder. To use the table, start with the actuation type presently being used on the instrument. Next, find the desired actuation in the proper column that lists the type of kit (by letter designation) required to make the change. The adjacent column for each type of actuation (or kit type) lists a reference figure that illustrates the proper signal input and range-card connections.

When ordering a kit, specify the desired measurement range and scale; also include the model and serial number of the instrument. If the kit type is for a thermocouple actuated input, also specify type of thermocouple. A description of the various kit types are listed in Table 3.12-2.

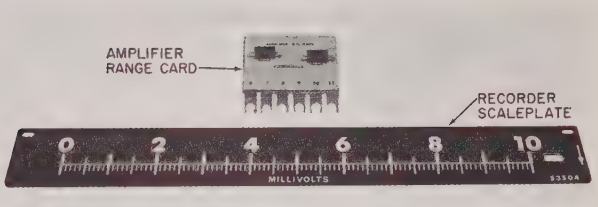


FIGURE 3.24. TYPICAL RANGE CHANGE KIT FOR MULTIPOINT RECORDERS.

Range Changing Procedures

Changing recorder range in the field may be accomplished by the following steps:

(1) Open case door, turn off POWER switch, and swing out frame assemblies from case.

WARNING: Dangerous potentials may exist within the recorder case. Exercise caution when contacting terminal connections.

(2) Remove range card cover (metal shield) from amplifier terminal block TB201.

TABLE 3.12-1. RANGE-CHANGING TABLE.

PRESENT ACTUATION		DESIRED ACTUATION AND/OR RANGE							
		DC MILLIVOLTS		THERMOCOUPLE		DC VOLTS		DC CURRENT	
ACTUATION TYPE	CONNECTION DIAGRAM (FIG. 3.24-1)	KIT TYPE	CONNECTION DIAGRAM (FIG. 3.24-1)	KIT TYPE	CONNECTION DIAGRAM (FIG. 3.24-1)	KIT TYPE	CONNECTION DIAGRAM (FIG. 3.24-1)	KIT TYPE	CONNECTION DIAGRAM (FIG. 3.24-1)
DC Millivolts (Zero Based)	A-1	A†	A-1 or A-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2
DC Millivolts (Zero Elevated or Zero Suppressed)	A-2	A	A-1 or A-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2
Thermocouple	D-1	A	A-1 or A-2	D	D-1	F	F-1 F-2	H	H-1 or H-2
DC Volts (Zero Based)	F-1	A	A-1 or A-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2
DC Volts (Zero Elevated or (Zero Suppressed)	F-2	A	A-1 or A-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2
DC Current (Zero Based)	H-1	A	H-1 or H-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2
DC Current (Zero Elevated or Zero Suppressed)	H-2	A	H-1 or H-2	D	D-1	F	F-1 or F-2	H	H-1 or H-2

† A Zero-Based Millivolt Range Card Having a Measurement Range Higher Than 1MV may be Converted to a 0-1MV Measurement Range by Connecting a Jumper Between Terminals 10 and 11 on the Range Card. (For Example, a 0-50MV Range Card is Converted to a 0-1MV Range Card When Jumper is Connected).

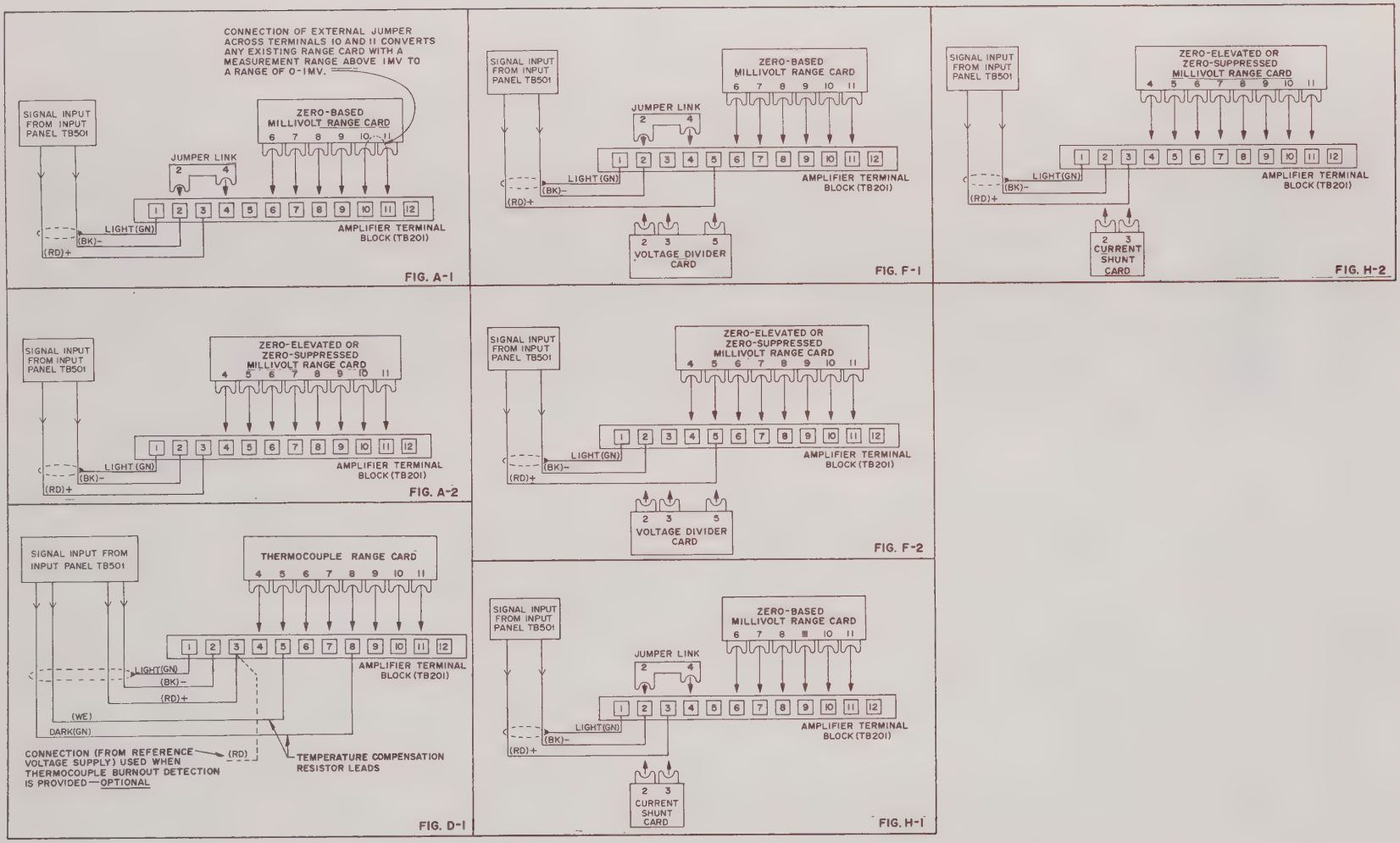


FIGURE 3.24-1. SIGNAL INPUT AND RANGE CARD CONNECTIONS.

(3) Loosen screw-type terminals which secure range card(s) to the amplifier terminal block (TB201). Remove range card(s).

(4) Connect numbered spade-lug terminals of range card (or cards) for new range to corresponding numbered terminals on the amplifier terminal block (TB201). Refer to proper connection diagram in Figure 3.24-1 as designated in Table 3.12-1. See that all connections are clean and tight.

(5) Replace scale and chart if required. See PART 2, SECTION II in this manual for charting instructions.

(6) Check mechanical calibration of instrument as described under subject heading "Mechanical Calibration Adjustments" in the MECHANICAL SERVICE ADJUSTMENTS instructions. After checking mechanical calibration, make final and precise electrical calibration adjustments as indicated under "Recorder Calibration".

TABLE 3.12-2. DESCRIPTION OF KIT TYPES.

KIT TYPE	DESCRIPTION
A	DC Millivolt Range Card and Stock Scale
D	Thermocouple Range Card and Stock Scale
F	DC Millivolt Range Card, Voltage Divider Card, and Stock Scale
H	DC Millivolt Range Card, Current Shunt Card, and Stock Scale

ELECTRICAL TROUBLESHOOTING

The procedures recommended in the following section are designed to facilitate locating the source of electrical trouble so that corrective steps may be taken and the instrument restored to service with minimum delay. A simplified troubleshooting guide is presented in Table 3.13. This table describes the most common trouble symptoms, lists the most probable causes, and suggests the most likely remedy procedures; and it should be found useful when attempting to isolate troubles to electrical modules and components of the recorder. For mechanical faults, see the "Mechanical Troubleshooting Guide" in Table 3.7 in the MECHANICAL MAINTENANCE section. Additional maintenance procedures for the chart drive may be found in PART 2, SECTION III of this manual.

TABLE 3.13. ELECTRICAL TROUBLESHOOTING GUIDE.

SYMPTOM	POSSIBLE CAUSE	REMEDY
(1) Chart drive, servo, and print systems inoperative.	Loss of line voltage.	Check power cord and AC source.
	Blown fuse.	Replace fuse F301. If new fuse blows, check for short in power wiring.
	Faulty connection.	Remove terminal mounting plate (beneath amplifier chassis) and check all wiring.

TABLE 3.13. ELECTRICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
Symptom (1) cont'd.	Defective switch.	Replace POWER switch S1 or CHART DRIVE switch S2 in chart drive module.
(2) Chart drive and servo systems operate. Print motor inoperative.	Print motor switch in OFF position or defective.	Place switch S303 in ON position or replace if defective.
	Faulty connection.	Check print motor wiring. See Table 3.14.
	Defective motor or starting capacitor.	Replace print motor B302 or capacitor C302.
(3) Chart drive and print motor operates. Servo system completely inoperative.	Loss of power.	Check power wiring to amplifier, reference supply, and balance motor B301. See Table 3.14.
	Amplifier gain misadjusted or defective amplifier.	Check GAIN setting, replace chopper CH201, or troubleshoot amplifier.
	Short in switch circuit.	Check signal-cutoff switch S302, and limit switch S301.
	Defective motor or phasing capacitor.	Replace capacitor C301. Test balance motor B301. See Table 3.14.
	Open input circuit. NOTE: For units without thermocouple burnout protection only.	If servo drives to zero or left end of span with input terminals shorted, repair or replace sensing element.
(4) Servo functions incorrectly on only certain points (or stations). NOTE: See additional Symptoms 7, 8, 10, 12, 13, and 14.	Faulty input circuit.	Check sensing element, input panel connections, connector (J301), and selector switch (S300).
	External interference.	Check sensing element and relocate. Check grounding, shielding, and routing of input leads. See "Rejection of Interference" in PART 3, SECTION II.
(5) Servo exhibits excessive overshoot.	DAMPING control misadjusted.	Increase setting of DAMPING control. Refer to "Operator Control Adjustment Procedures" in PART 3, SECTION II.
(6) Servo fails to reach value of measured input within normal response time.	Source resistance too high, or DAMPING control misadjusted.	See that source is less than 10K ohms. Adjust damping as required.

TABLE 3.13. ELECTRICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
(7) Sluggish servo operation, excessive deadband, and abnormally slow response time.	Source resistance too high, or excessive input noise.	See that source is less than 10K ohms. See "Rejection of Interference" in PART 3, SECTION II.
	Control misadjusted or defective amplifier.	Increase GAIN or decrease DAMPING; replace chopper CH201, or troubleshoot amplifier.
	Defective phasing capacitor or balance motor.	Check or replace C301 and B301. See Table 3.14.
(8) Servo has erratic operation, or printhead oscillates.	Amplifier gain misadjusted.	Reduce GAIN setting. Refer to "Operator Control Adjustment Procedures" in PART 3, SECTION II.
	Excessive input noise.	See "Rejection of Interference" in PART 3, SECTION II.
	Faulty connection.	Check range card and input signal connections.
	Defective slidewire or motor.	Check slidewire R300, and balance motor B301. See Table 3.14.
(9) Servo drives to one extreme end of span. NOTE: Instruments with thermocouple burnout protection only.	Faulty connection or open sensing element.	Check signal input connections. Repair or replace sensing element.
(10) Servo drives to one extreme end of span with normal input signal. NOTE: Check polarity of input connections.	Open measuring circuit.	Check connections, range card, and ZERO control circuit. See Table 3.14.
	Loss of reference voltage.	Check connections. Repair or replace reference supply.
	Open slidewire circuit.	Check slidewire and associated wiring. See Table 3.14.
	Defective amplifier.	Replace chopper CH201. Troubleshoot amplifier. See "Amplifier Servicing."
(11) Recorded values consistently high or low for all known input signals.	Wrong type of sensing element or defective element.	Test or replace sensing element.
	Amplifier ZERO misadjusted.	Check ZERO setting and recalibrate if necessary.

TABLE 3.13. ELECTRICAL TROUBLESHOOTING GUIDE (CONT'D).

SYMPTOM	POSSIBLE CAUSE	REMEDY
SYMPTOM (11) CONT'D.	DEFECTIVE RANGE CARD OR AMPLIFIER.	REPLACE RANGE CARD. TROUBLESHOOT AMPLIFIER. SEE TABLE 3.14.
(12) INSTRUMENT RECORDS AMBIENT TEMPERATURE OF CASE (IF WITHIN SPAN) INSTEAD OF ANTICIPATED VALUE. NOTE: FOR TEMPERATURE RECORDERS ONLY.	SIGNAL INPUT SHORTED NEAR REFERENCE JUNCTION.	CHECK LEADS AND CONNECTIONS AT INPUT PANEL. INSULATE LEADS IF NECESSARY.
(13) INSTRUMENT RECORDS SOME EXTERNAL AMBIENT TEMPERATURE (IF WITHIN SPAN) INSTEAD OF ANTICIPATED VALUE. NOTE: FOR TEMPERATURE RECORDERS ONLY.	SHORT AT THERMOCOUPLE.	INSPECT THERMOCOUPLE. REPLACE IF NECESSARY.
	SHORTED EXTENSION WIRES.	SEPARATE AND INSULATE WIRES AS REQUIRED.
(14) RECORDER WILL NOT CALIBRATE WITHIN TOLERANCE.	MECHANICAL FAULT.	SEE "MECHANICAL TROUBLESHOOTING GUIDE," TABLE 3.7 IN MECHANICAL MAINTENANCE SECTION.
	UNRELIABLE SIGNAL SOURCE.	USE KNOWN-ACCURATE SOURCE AND FOLLOW RECOMMENDED PROCEDURES ONLY.
	OPERATOR CONTROLS MISADJUSTED.	SEE "OPERATOR CONTROL ADJUSTMENT PROCEDURES" IN PART 3, SECTION II.
	DEFECTIVE ELECTRICAL MODULE OR COMPONENT.	SEE "TEST PROCEDURES GUIDE" OF TABLE 3.14.

TEST PROCEDURES

AFTER PRELIMINARY INVESTIGATIONS INDICATE THAT A TROUBLE IS IN THE RECORDER AND POSSIBLE MECHANICAL MALFUNCTIONS AS WELL AS OPERATOR ADJUSTMENTS HAVE BEEN CHECKED, THE MOST LOGICAL TROUBLESHOOTING APPROACH IS TO ISOLATE THE FAULT TO ONE ELECTRICAL MODULE--SUCH AS THE AMPLIFIER, REFERENCE VOLTAGE SUPPLY, BALANCE MOTOR, SLIDEWIRE, RANGE CARD, PRINT MOTOR, ETC.

THE TEST PROCEDURE GUIDE IN TABLE 3.14 HAS BEEN PREPARED TO ASSIST THE SERVICEMAN IN EVALUATING THE OPERATIONAL CONDITION OF THE VARIOUS ELECTRICAL MODULES.

THE TABLE GIVES THE TYPE OF TESTS RECOMMENDED, INSTRUCTIONS FOR SETTING UP THE TESTS, AND NORMAL INDICATIONS THAT EACH TEST SHOULD PRODUCE. IF AN ABNORMAL INDICATION IS NOTED, REFER TO THE ACCOMPANYING SCHEMATICS AND WIRING DIAGRAMS IN FIGURES 3.27, 3.28 3.29, AND 3.30 AT THE END OF THIS SECTION (SECTION III).

NOTE: WHEN PERFORMING THE VOLTAGE MEASUREMENTS DESCRIBED IN TABLE 3.14, POWER MUST BE APPLIED TO THE INSTRUMENT; HOWEVER, REMEMBER TO TURN OFF ALL POWER WHEN RESISTANCE MEASUREMENTS ARE MADE.

TABLE 3.14. TEST PROCEDURE GUIDE.

TEST DESCRIPTION	TEST INSTRUCTION	NORMAL INDICATION	
AC POWER TESTS	CONNECT AC METER LEADS ACROSS TERMINALS: C AND B OF CP301. F AND B OF CP301 (S1 "ON"). D AND B OF CP301 (S1,S2 "ON").	120V, ±10% (50/60 Hz)	
	9 AND 10 OF TB401.	120V, ±10% (50/60 Hz)	
	1 AND 3 OF TB303 (WITH S303 "ON").	120V, ±10% (50/60 Hz)	
REFERENCE VOLTAGE MEASUREMENT	CONNECT DC METER LEADS ACROSS TERMINALS 6 AND 9 OF TB201. (+) TO TERMINAL 6.	+6.5V DC (±5%)	
VOLTAGE CHECK OF BALANCE MOTOR REFERENCE WINDING	CONNECT AC METER LEADS ACROSS TERMINALS 8 AND 9 OF TB401.	100V, ±10% (50/60 Hz)	
SERVO AMPLIFIER OUTPUT TESTS	CONNECT (+) METER LEAD TO TERMINAL 6 OF TB401. CONNECT (-) LEAD TO TERMINAL:		
	5 OF TB401	-1.5V DC, ±10%;	6V AC, ±10%
	7 OF TB401	-1.5V DC, ±10%;	6V AC, ±10%
AMPLIFIER VOLTAGE CHECK AT INPUT TO POWER STAGE	CONNECT DC METER LEADS ACROSS TERMINALS 3 AND 4 OF TB401 (WITH + TO TERMINAL 3 AND S302 "OPEN").	0V DC	
VOLTAGE TEST OF PHASING CAPACITOR (C301)	CONNECT AC METER LEADS ACROSS TERMINALS 1 AND 8 OF TB401 OR (D AND E OF CP301).	170V, ±10% (50/60 Hz)	
AMPLIFIER VOLTAGE MEASUREMENTS AT INPUT TERMINAL BLOCK. (TYPICAL ZERO-BASED MV RECORDERS ONLY)	JUMPER TERMINALS 2, 3, AND 4 OF TB201. CONNECT (-) LEAD OF DC METER TO 2 OF TB201. CONNECT (+) LEAD TO TERMINAL:		
	6 OF TB201	+6.1V DC, ±10%	
	7 OF TB201	+.3V DC, ±10%*	
	8 OF TB201 (REVERSE POLARITY)	-.3V DC, ±10%*	
	9 OF TB201 (REVERSE POLARITY)	-.3V DC, ±10%	
	10 OF TB201	≅0.V DC (AT NULL FOR 1 TO 100MV RANGES)	

TABLE 3.14. TEST PROCEDURE GUIDE (CONT'D).

TEST DESCRIPTION	TEST INSTRUCTION	NORMAL INDICATION
AMPLIFIER VOLTAGE (CONT'D.)	11 OF TB201	≅0.V DC (AT NULL BALANCE)
	12 OF TB201	≅0.V DC (AT NULL BALANCE)
	12 OF TB201 WITH FULL-SCALE DEFLECTION.	+3.0V DC, ±10%*
	*READINGS TAKEN WITH ZERO CONTROL IN NORMAL MID-RANGE POSITION.	
IN-CIRCUIT VOLTAGE CHECK OF SLIDEWIRE (R300)	CONNECT (-) LEAD OF DC METER TO TERMINAL 9 AND (+) LEAD TO TERMINAL 12 OF TB201.	
	POSITION SERVO AT LOW END OF SPAN.	+.4V DC, ±10%
	POSITION SERVO AT HIGH END OF SPAN.	+3.3V DC, ±10%
IN-CIRCUIT RESISTANCE CHECK OF SLIDEWIRE (R300)	DISCONNECT BLACK WIRE FROM TERMINAL 9 OF TB201 AND CONNECT METER LEADS ACROSS CW AND CCW TERMINALS OF R300.	640Ω, ±5%
	CAUTION: DO NOT MEASURE SLIDEWIRE END RESISTANCE. OHMMETER CURRENTS MAY DAMAGE RESISTIVE ELEMENT.	
IN-CIRCUIT RESISTANCE CHECK OF BALANCE MOTOR (B301)	CONNECT METER LEADS ACROSS TERMINALS 5 AND 7 OF TB401.	45Ω, ±20%
BALANCE MOTOR (B301) RESISTANCE MEASUREMENTS	DISCONNECT MOTOR LEADS FROM TERMINALS 5, 6, AND 7 OF TB401. CONNECT METER LEADS ACROSS:	
	WHITE AND BLACK MOTOR LEADS.	50Ω, ±20%
	BLACK AND BLUE MOTOR LEADS.	25Ω, ±20%
	WHITE AND BLUE MOTOR LEADS.	25Ω, ±20%
IN-CIRCUIT RESISTANCE CHECK OF RANGE CARD	DISCONNECT RED AND BLACK WIRES FROM TERMINALS 6 AND 9 OF TB201. CONNECT METER LEADS ACROSS TERMINALS 6 AND 9 OF TB201.	1857Ω, ±1%
RESISTANCE MEASUREMENT OF TEMPERATURE COMPENSATOR ON INPUT PANEL TB501 (TEMPERATURE RECORDERS ONLY)	DISCONNECT WHITE AND GREEN LEADS FROM TERMINALS 5 AND 8 OF TB201. CONNECT METER LEADS ACROSS WHITE AND GREEN LEADS FROM TB501.	140Ω, ±1%, @ 90°F (APPROX. CHANGE .3Ω/°F.)

TABLE 3.14. TEST PROCEDURE GUIDE (CONT'D).

TEST DESCRIPTION	TEST INSTRUCTION	NORMAL INDICATION
PRINT MOTOR (B302) RESISTANCE MEASUREMENTS	Turn off print motor switch S303. Connect meter leads across terminals:	
	2 and 3 of TB303	1300Ω, ±10%
	2 and 1 of TB303	650Ω, ±10%
	3 and 1 of TB303	650Ω, ±10%

AMPLIFIER SERVICING

If test procedures indicate that trouble is in the servo amplifier, it will be necessary to either replace the entire amplifier assembly or service the chassis in the field by employing conventional troubleshooting techniques.

Instructions for removing the entire amplifier assembly from the case (for replacement purposes) are described under topic heading "Components Replacement" in this section of the manual. If the amplifier is to be serviced in the field, however, remove amplifier to a serviceable position as described below.

A complete schematic diagram of the amplifier is shown in Figure 3.28. If adequate repair facilities are not available, contact your nearest Esterline Angus field representative.

OBTAINING SERVICEABLE POSITION OF AMPLIFIER

Before any of the servicing procedures can be performed on the amplifier printed circuit board, it is necessary to place the amplifier in a serviceable position. Proceed as follows:

(1) Turn off POWER and CHART DRIVE switches, and swing out frame assemblies.

WARNING: Dangerous potentials may be present within the recorder case Exercise caution when contacting terminal connections.

(2) Loosen 2 screws. Lift up and remove range card cover (metal shield) from amplifier terminal block TB201. Identify (mark, tag) and remove all cable leads which connect to TB201.

(3) Remove following cable clamps: one clamp from lower front, right-hand corner of amplifier; three clamps from top of amplifier and two clamps from left side of case (the two clamps nearest amplifier).

(4) Pull forward on left-and right-hand slide latches to release the amplifier. Lift amplifier assembly straight up and then pull forward to place amplifier in a serviceable position. Lift and remove amplifier cover to expose printed circuit board.

WARNING: The amplifier assembly is mounted on insulators to completely float (isolate) the amplifier from the system ground or instrument case ground (⏚). A warning decal--stating that the amplifier chassis floats at a common-mode potential with respect to the instrument case--is attached to the top of the amplifier. Henceforth, care should be exercised to avoid shock to person and possible damaging shorts to the equipment when servicing an amplifier that is operating with an off-ground signal connected to terminal block TB201. Do Not float amplifier at off-ground voltage exceeding 120V AC or 300V DC.

OPERATOR CONTROL ADJUSTMENTS

Improper operator control adjustments can result in amplifier trouble symptoms. If the GAIN control is set too high, for example, a slight oscillation of the system may be noticed. Refer to "Operator Control Adjustment Procedures" as outlined in SECTION II (Operation) of PART 3 in this manual.

ZERO CONTROL (R235)

A SIMPLE CHECK OF THE ZERO CONTROL CIRCUIT MAY BE MADE WITHOUT REMOVING THE AMPLIFIER BY FIRST REMOVING THE RANGE CARD AND THEN MEASURING THE DC RESISTANCE ACROSS TERMINALS 7 AND 8 OF TB201. THE TOTAL CONTROL RESISTANCE SHOULD BE ABOUT 200 OHMS. FROM THE ARM OF THE CONTROL (TERMINAL 2 OF TB201) TO EITHER SIDE (EITHER TERMINAL 7 OR 8 OF TB201), THE RESISTANCE SHOULD VARY SMOOTHLY BETWEEN ZERO AND 200 OHMS AS THE CONTROL IS ADJUSTED.

CAUTION: IF THE ZERO CONTROL IS ADJUSTED, INSTRUMENT RECALIBRATION WILL USUALLY BE NECESSARY. REFER TO "RECORDER CALIBRATION" INSTRUCTIONS IN THIS SECTION OF THE MANUAL.

CHOPPER (CH201) AND CHOPPER TRANSFORMER (T201)

TO SERVICE EITHER THE CHOPPER OR CHOPPER TRANSFORMER, IT WILL BE NECESSARY TO PLACE THE AMPLIFIER IN A SERVICEABLE POSITION. OBTAIN SERVICEABLE POSITION OF AMPLIFIER AS DESCRIBED ABOVE.

CHOPPER (FIGURE 3.25)

THE GAIN OF THE SOLID-STATE AMPLIFIER WILL NORMALLY REMAIN HIGHLY STABLE AND THE ONLY COMPONENT THAT HAS A MORE-OR-LESS LIMITED LIFE EXPECTANCY IS THE CHOPPER. IF THE SERVO SYSTEM IS DEAD, OR THE PEN HAS A TENDENCY TO VIBRATE, OR RESPONSE SEEMS SLUGGISH, REPLACE THE CHOPPER BEFORE CHANGING ANY OF THE OPERATOR CONTROL ADJUSTMENTS.

THE CHOPPER CAN BE TESTED TO SOME EXTENT BY GRASPING IT LIGHTLY WITH THE FINGERS AND CHECKING FOR VIBRATION. IF THE SERVO SYSTEM IS INOPERATIVE, AND NO VIBRATION CAN BE FELT IN THE CHOPPER, REPLACE THE UNIT; IF THIS RESTORES OPERATION, NO FURTHER TESTING IS NECESSARY.

IF THE SERVO IS STILL INOPERATIVE AFTER CHOPPER REPLACEMENT AND NO VIBRATION IS FELT IN THE NEW UNIT, REMOVE THE CHOPPER AND TEST FOR APPROXIMATELY 6.3V AC BETWEEN CONTACTS 3 AND 4 OF THE CHOPPER SOCKET. IF DRIVE VOLTAGE IS NOT PRESENT AT THESE POINTS, CHECK CIRCUIT CONTINUITY. THE CHOPPER DRIVE WINDING OF THE POWER TRANSFORMER SHOULD HAVE A RESISTANCE OF ABOUT 2.5 OHMS.

CHOPPER TRANSFORMER (FIGURE 3.25)

CHECK CHOPPER TRANSFORMER AS FOLLOWS:

(1) REMOVE CHOPPER FROM ITS SOCKET. CONNECT OHMMETER ACROSS PINS 1 AND 6 OF THE CHOPPER SOCKET. PRIMARY WINDING OF CHOPPER TRANSFORMER SHOULD HAVE A NOMINAL RESISTANCE VALUE OF 920 OHMS.

(2) CONNECT OHMMETER ACROSS TEST POINTS TP202 AND TP230 ON PRINTED CIRCUIT BOARD (FIGURE 3.25). SECONDARY WINDING OF CHOPPER TRANSFORMER SHOULD HAVE A NOMINAL RESISTANCE VALUE OF 650 OHMS.

AMPLIFIER TEST POINTS

WHEN TROUBLE SYMPTOMS POINT TO INTERNAL FAULTS IN THE AMPLIFIER, IT WILL BE NECESSARY TO REMOVE AMPLIFIER TO A SERVICEABLE POSITION IN ORDER TO GAIN ACCESS TO THE TEST POINTS ON THE AMPLIFIER PRINTED CIRCUIT BOARD. OBTAIN SERVICEABLE POSITION OF AMPLIFIER AS DESCRIBED ABOVE.

NOMINAL DC VOLTAGE READINGS ARE INDICATED FOR VARIOUS TEST POINTS ON THE AMPLIFIER PRINTED CIRCUIT BOARD SCHEMATIC SHOWN IN FIGURE 3.28. THE PHYSICAL LOCATION OF EACH TEST POINT IS SHOWN IN FIGURE 3.25. ALL VOLTAGE MEASUREMENTS WERE TAKEN WITH A 20,000 OHM/VOLT METER REFERENCED TO EITHER FLOATING SIGNAL GROUND (⏚) OR AMPLIFIER CHASSIS GROUND (⏚). FLOATING SIGNAL GROUND IS THE COMMON RETURN CIRCUIT OF THE PRINTED CIRCUIT BOARD AND CONNECTS TO TERMINAL 1 (AMPLIFIER CHASSIS GROUND) OF TB201.

IF VOLTAGES AT ANY OF THE AMPLIFIER TEST POINTS ARE FOUND TO BE ABNORMAL, ALL ASSOCIATED CIRCUIT COMPONENTS SHOULD BE CHECKED THOROUGHLY BEFORE ATTEMPTING TO REPLACE TRANSISTORS. WHEN REPLACING DIODES OR TRANSISTORS, BE SURE TO USE A SUITABLE HEAT-SINK AND ONLY THE MINIMUM REQUIRED HEAT. WHEN REPLACING COMPONENTS IN THE MEASURING CIRCUIT OR INPUT CIRCUITRY OF THE AMPLIFIER, ALWAYS USE A LOW-THERMAL SOLDER SUCH AS "KIRKSON LT" OR EQUIVALENT.

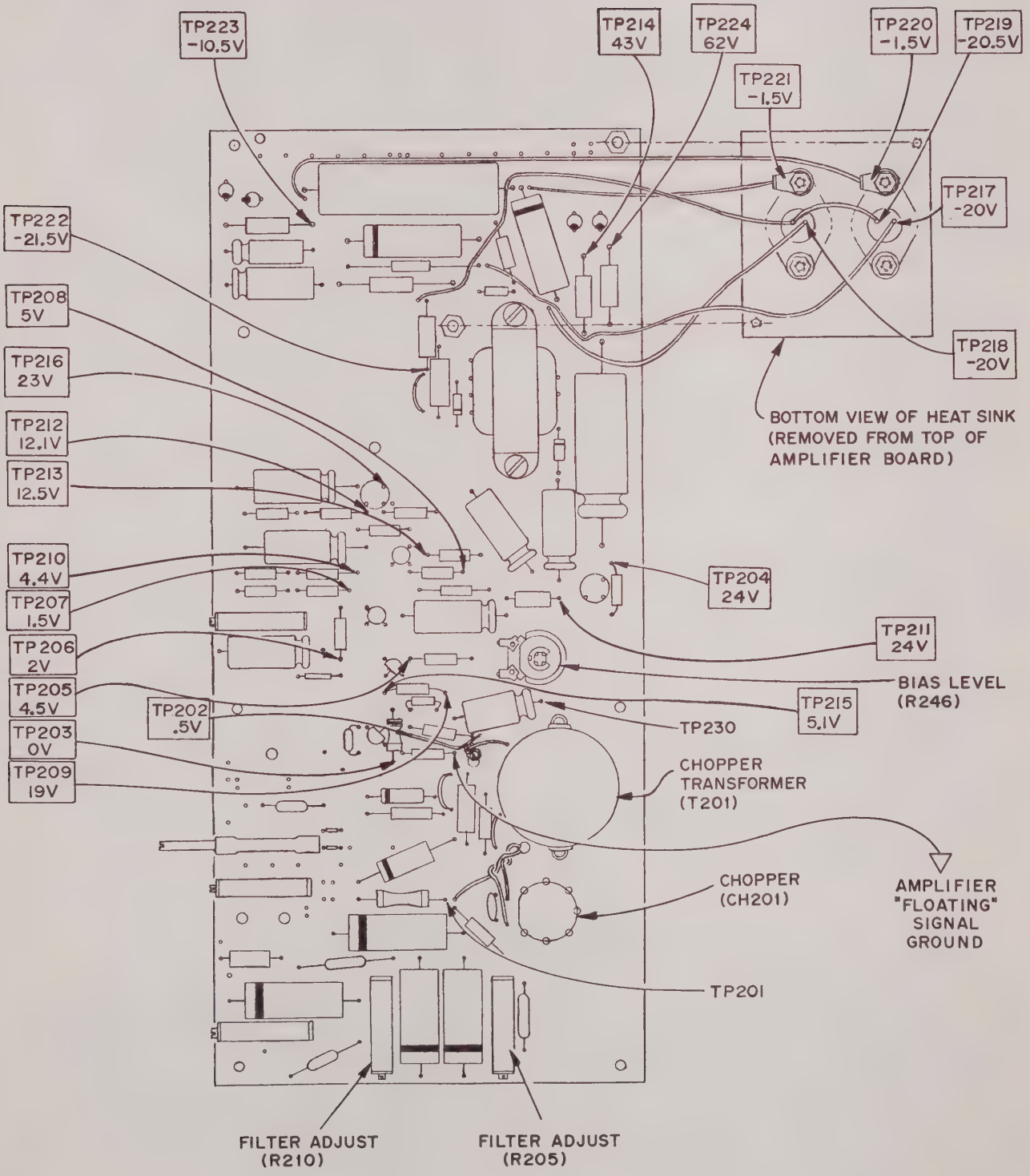


FIGURE 3.25. LOCATION OF TEST POINTS ON AMPLIFIER PRINTED CIRCUIT BOARD.

INTERFERENCE AND NOISE

External interference or internally-generated noise may upset the proper operation of the servo amplifier. These spurious signals can cause the amplifier to saturate, thus resulting in sluggish operation and insensitivity to changes in the measured voltage. Stray pickup or circuit regeneration may also cause undesirable oscillations and vibrations of the pen.

The first step in isolating the source of interference is to short the signal input terminals of the amplifier by placing a jumper across terminals 2, 3, and 4 of TB201. If the trouble symptoms are no longer present, the most probable cause is external interference. Refer to the instructions described under "Interference Voltages" in SECTION II (Operation) of PART 3. Also check for a noisy slidewire, R300.

If the trouble symptoms are present on all points (stations) and they do not disappear when the signal-input terminals are shorted, it is more likely that the fault is in the amplifier. Check for one or more of the following possible troubles:

(1) Loose connection at amplifier terminal block (TB201) or at cable socket on amplifier plug.

(2) Noisy chopper (CH201).

(3) Poor solder joint in amplifier.

(4) Input filter adjustment incorrectly tuned.

(5) Defective chopper transformer (T201)

(6) Defective component in input filter circuit.

(7) Open by-pass or decoupling capacitor (C211, C212, C213, C214, C216, or C217).

The input filter controls, R205 and R210 should not be adjusted in the field until all other possible causes of interference have been eliminated. If adjustment is deemed necessary, refer to the procedures given under ELECTRICAL SERVICE ADJUSTMENTS in this section of the manual.

If a satisfactory filter adjustment cannot be obtained by following the recommended procedures, make the following checks:

(1) If meter makes a very sudden change when an adjustment passes a certain point, the filter control may be open. Check resistance of control and replace if defective. Use low-thermal solder such as "Kirkson LT" or equivalent.

(2) If meter does not respond to any change in filter adjustments, check control and series resistors for an open. Also check all solder joints.

(3) Check for open capacitors in the filter circuit by paralleling each unit with a suitable substitute.

REFERENCE SUPPLY SERVICING

When test procedures isolate trouble to the reference voltage supply, it will be necessary to either replace the entire supply assembly or service the module in the field by employing conventional troubleshooting techniques.

Instructions for removing the entire reference supply module from the main frame mechanism (for replacement purposes) are described under topic heading "Components Replacement" in this section of the manual. If the supply is to be serviced in the field, however, it will only be necessary to remove the cover from the module in order to troubleshoot the printed circuit board. The cover is removed from the module as follows:

(1) Open case door, turn off POWER and CHART DRIVE switches, and swing out frame assemblies.

(2) Remove 3 screws that secure the supply cover to the rear side of the main frame mechanism. Remove cover.

A COMPLETE SCHEMATIC DIAGRAM OF THE SUPPLY IS INCLUDED IN FIGURE 3.28. IF ADEQUATE REPAIR FACILITIES ARE NOT AVAILABLE, CONTACT YOUR NEAREST ESTERLINE ANGUS FIELD REPRESENTATIVE.

THE NORMAL REFERENCE OUTPUT VOLTAGE IS 6.5V DC (±5%) MEASURED ACROSS TERMINALS 6 AND 9 OF THE AMPLIFIER TERMINAL BLOCK, TB201. IF AN ABNORMAL VOLTAGE IS FOUND AT THIS POINT, DISCONNECT THE RED AND BLACK LEADS FROM TERMINALS 6 AND 9 AND SUBSTITUTE AN 1800-OHM (±5%) RESISTOR ACROSS THE REFERENCE OUTPUT LEADS AS A DUMMY LOAD. IF THE REFERENCE VOLTAGE RETURNS TO NORMAL, THE FAULT IS PROBABLY IN THE AMPLIFIER OR OTHER MEASURING-CIRCUIT COMPONENTS (SEE TABLE 3.14). IF THE TROUBLE SYMPTOM PERSISTS, TEST THE SLIDEWIRE CIRCUIT AND CHECK FOR AC POWER SUPPLIED TO THE MODULE FROM TERMINALS 9 AND 10 OF TB401.

WHEN TROUBLE SYMPTOMS INDICATE AN INTERNAL FAULT IN THE REFERENCE SUPPLY, REMOVE COVER FROM SUPPLY AS DESCRIBED ABOVE SO THAT SUPPLY MAY BE SERVICED.

REFERENCE SUPPLY TESTING

A VIEW SHOWING THE LOCATION OF KEY TEST POINTS IS ILLUSTRATED IN FIGURE 3.26. THESE SAME TEST POINTS ARE SHOWN ON THE SCHEMATIC IN FIGURE 3.28.

AC Input Voltage

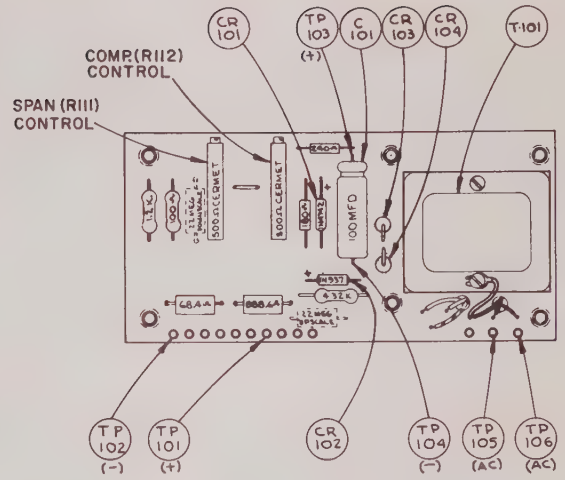
THE AC INPUT VOLTAGE APPLIED TO THE REFERENCE VOLTAGE SUPPLY SHOULD MEASURE 120V AC (±10%) BETWEEN TEST POINTS TP105 AND TP106.

DC Output Voltage

THE DC OUTPUT VOLTAGE OF THE SUPPLY MAY BE CONVENIENTLY MEASURED BETWEEN TEST POINTS TP101 AND TP102. THE NORMAL OPERATING VOLTAGE AT THESE POINTS SHOULD BE 6.5V DC (±5%).

OUTPUT LIMITS OF THE SUPPLY MAY BE VARIED FROM APPROXIMATELY 4.8 TO 7.0V DC BY ADJUSTMENT OF THE COMP CONTROL. HOWEVER, IF EITHER THE COMP OR SPAN ADJUSTMENT IS DISTURBED, RECALIBRATION OF THE INSTRUMENT WILL BE NECESSARY. THEREFORE, IT IS STRONGLY RECOMMENDED THAT ALL OTHER POSSIBLE FAULTS BE EXAMINED BEFORE RESETTING THE COMP OR SPAN CONTROLS. REFER TO "RECORDER CALIBRATION" INSTRUCTIONS IN THIS SECTION OF THE MANUAL.

IF THE OUTPUT VOLTAGE OF THE SUPPLY IS VERY LOW AND OF A REVERSED POLARITY, CHECK FOR AN OPEN COMP CONTROL (R112) OR FOR A SHORTED ZENER DIODE (CR102). IF



TEST VOLTAGES

BETWEEN TP101 AND TP102 = 6.5VDC (+) (-) ±5%

BETWEEN TP103 AND TP104 = 21VDC (+) (-) ±10%

BETWEEN TP105 AND TP106 = 120VAC ±10%

FIGURE 3.26. LOCATION OF TEST POINTS ON REFERENCE VOLTAGE SUPPLY PC BOARD.

THERE IS A COMPLETE LOSS OF OUTPUT, CHECK FOR AN OPEN CONNECTION AND TEST T101, CR103, AND CR104.

THE NORMAL OPERATING VOLTAGE BETWEEN TEST POINTS TP103 AND TP104 IS 21V DC (±10%). IF THIS VOLTAGE IS ABNORMAL, CHECK C101, CR103, AND CR104.

AN OSCILLOSCOPE SHOULD ALSO BE USED TO MEASURE THE 120-Hz RIPPLE AT THE REFERENCE SUPPLY OUTPUT. THE RIPPLE SHOULD NOT EXCEED 100µv PEAK-TO-PEAK BETWEEN TP101 AND TP102. IF EXCESSIVE RIPPLE IS PRESENT, CHECK CAPACITOR C101 BY SUBSTITUTION.

Output Voltage Regulation

IF RECORDER CALIBRATION TENDS TO SHIFT AND REPEATABILITY IS POOR, LOSS OF REGULATION MAY BE THE TROUBLE. CHECK FOR AN OPEN ZENER DIODE (CR102). IF THE VOLTAGE ACROSS THIS DIODE IS MORE THAT 9.0V DC, IT IS OPEN. IF CR102 IS FOUND DEFECTIVE, ALSO CHECK CR101 SINCE IT MIGHT HAVE CAUSED CR102 TO FAIL. IF CR101 IS OPEN, THE VOLTAGE ACROSS IT WILL USUALLY INCREASE TO ABOUT 14V DC.

NOTE: THE REFERENCE VOLTAGE MAY INCREASE SLIGHTLY WHEN THE RANGE CARD OR SLIDEWIRE IS DISCONNECTED. THIS IS NORMAL AND NOT AN INDICATION OF POOR REGULATION.

COMPONENTS REPLACEMENT

All of the major components mounted within the recorder case and on the swing-out frame assemblies are readily accessible for easy removal and replacement.

Previous troubleshooting and testing procedures may reveal that certain components have become defective, thus necessitating their removal and replacement in order to restore proper instrument operation.

The instructions for the removal and replacement of a number of these components are given below.

NOTE: For disassembly or replacement of components pertaining to the chart drive, refer to PART 2, SECTION III in this manual.

WARNING: Before proceeding with the disassembly and replacement of components, remove AC power source from instrument or open case door and turn off POWER switch.

MAIN FUSE (F301)

To Remove

(1) Swing out frame assemblies from case.

(2) Turn fuse extractor post counterclockwise and remove from fuse holder. Remove fuse from extractor post.

To Replace

(1) Install new fuse in extractor post.

CAUTION: Do not use fuses of higher electrical rating than that of the original type.

(2) Insert extractor post into fuse holder and turn clockwise to lock in place.

CHOPPER

To Remove

(1) Obtain serviceable position of amplifier as described under topic heading "Amplifier Servicing" in this section of the manual.

(2) Pull chopper (CH201, Figure 3.25) straight up to unplug from printed circuit board.

To Replace

(1) Plug new chopper into its socket on printed circuit board and check operation.

CAUTION: Use an original factory replacement only.

(2) Place top cover on amplifier. Reinstall amplifier to case. Secure all cable clamps in their respective mounting positions. Restore all cable lead connections to TB201. Reinstall range card cover.

SLIDEWIRE

To Remove

(1) Swing out frame assemblies from case. Unlatch chart drive frame from main frame mechanism.

(2) Refer to Figure 3.21-1 and disassemble the servo gear-train components in the sequence shown.

(3) If idler gear is used, scribe the marks "A" as shown in Figure 3.21-1. If idler gear is not used, scribe the marks "B" as shown in Figure 3.21-1. The scribe marks are used for reference purposes during the reassembly procedures.

(4) Observe and make note of color-coding of leads connected to the S, CCW, and CW terminals of the slidewire. Connections to the slidewire are shown schematically in Figure 3.28. Also make note of the angular position of the slidewire terminals so that the replacement slidewire may assume the same relative position. Unsolder leads from slidewire.

(5) Use 1/16" hex (Allen) wrench and remove hub and gear assembly from slidewire shaft.

(6) Loosen the 3 mounting-dog screws and turn flats of mounting dogs to allow for slidewire clearance. Remove slidewire.

To Replace

(1) Place new slidewire in mounting position. Turn the 3 mounting dogs so that their rounded portions rest against the mounting lip of the slidewire body. Snug down (don't tighten) mounting-dog screws. Turn slidewire body so that terminals approximately attain the same angular position as the original slidewire terminals.

(2) Observing previous color-coding identification, solder the 3 leads to the slidewire terminals. Use a low-thermal solder, such as "Kirkson LT" or equivalent.

(3) Install original hub and gear assembly on shaft of new slidewire. Use 1/16" hex (Allen) wrench and tighten setscrew so that it bears against the flat of the slidewire shaft.

(4) Turn hub and gear assembly so that scribe mark on hub is aligned with scribe mark "A" or "B". (See scribing of marks in Step 3 in the removal instructions above.

(5) Reassemble the servo gear-train components in the sequence shown in Figure 3.21-1.

Preliminary Setting of Slidewire

(1) Turn off CHART DRIVE switch and turn on POWER switch. Allow instrument to warm up.

(2) Manually displace printhead downscale until overtravel mechanical stop is reached.

(3) Connect positive (+) and negative (-) leads of voltmeter (0-10V range) across terminals 6 and 9 respectively of terminal block TB201. Adjust COMP control for 6.5-volt reading on voltmeter.

(4) Remove positive lead of voltmeter from terminal 6 and connect to terminal 12 of TB201. Leave negative lead connected to terminal 9. Observe voltmeter reading. Slowly rotate body of slidewire in the required direction until voltmeter reads +0.4 volts DC. Disconnect voltmeter leads and completely tighten the 3 mounting-dog screws that secure the slidewire.

(5) Check mechanical calibration of instrument as described under subject heading "Mechanical Calibration Adjustments" in the MECHANICAL SERVICE ADJUSTMENTS instructions in this section of the manual. After checking mechanical calibration, make final and precise electrical calibration adjustments as indicated under topic heading "Recorder Calibration" in this section of the manual.

RANGE CARD (S)

NOTE: If the original measurement range of the instrument is to be changed, refer to "Range Changing" instructions in this section of the manual.

To Remove

(1) Swing out frame assemblies from case.

WARNING: Dangerous potentials may exist within the recorder case. Exercise caution when contacting terminal connections.

(2) Remove range card cover (metal shield) from amplifier terminal block TB201.

(3) Loosen screw-type terminals which secure range card(s) to the amplifier terminal block (TB201). Remove range card(s).

To Replace

(1) Connect numbered spade-lug terminals of range card(s) to corresponding numbered terminals on the amplifier terminal block (TB201). Make sure that all connections are clean and tight.

NOTE: If a zero-based millivolt range card is installed, the attached jumper strap connects between terminals 2 and 4 on TB201.

(2) Reinstall range card cover (metal shield) on TB201.

(3) Recalibrate instrument as outlined under "Recorder Calibration" in this section of the manual.

MULTIPLE-SIGNAL INPUT PANEL (TB501)

To Remove

(1) Swing out frame assemblies from case.

WARNING: Dangerous potentials may exist within the recorder case. Exercise caution when contacting terminal connections.

(2) Remove four screws from top cover of input panel. Remove top cover to expose connection terminals.

(3) Identify (mark, tag) all point (station) signal input leads. Remove all leads from screw terminals of input panel.

(4) Unscrew standoff stud assembly from each corner of the input panel. Pull input panel forward and face front side of panel downward toward top of amplifier.

(5) Identify (mark, tag) all wires connected to the solder terminals on rear side of input panel. Unsolder all wires from rear of input panel. Remove input panel from case.

To Replace

(1) Solder all wires to rear side of new input panel as originally identified in Step 5 under the removal instructions above. Use a low-thermal solder, such as "Kirkson LT" or equivalent.

(2) Mount input panel with the four standoff stud assemblies.

(3) Reconnect all point (station) signal input leads to the proper terminals on input panel as originally identified in Step 3 under the removal instructions above.

(4) Dress all signal input connections on panel so that wiring is routed through rectangular cutout formed between top and bottom covers when top cover is mounted in place to enclose the connection panel.

(5) Replace and tighten the four top cover retaining screws.

AMPLIFIER

To Remove

NOTE: The following instructions are given for the complete removal of the amplifier assembly from the instrument case. To gain access to the amplifier printed circuit board for servicing procedures alone, refer to topic heading "Amplifier Servicing" in this section of the manual.

(1) Open case door, turn off POWER and CHART DRIVE switches, and swing out frame assemblies.

WARNING: Dangerous potentials may be present within the recorder case. Exercise caution when contacting terminal connections.

(2) Remove range card cover (metal shield) from amplifier terminal block TB201. To prevent damaging the range card, loosen the appropriate mounting screws on TB201 and remove the card from the amplifier. If an additional voltage-divider or current-shunt card is used, it too should be removed from the terminal block.

(3) Identify (mark, tag) and remove all interconnecting leads from TB201. Free cable clamps which are attached to top and front of amplifier. Disconnect cable socket (J102) from amplifier plug (P201). Dress cables away from amplifier chassis.

(4) Pull forward on left- and right-hand slide latches to release the amplifier. Lift amplifier assembly straight up and then pull forward to remove the entire assembly from the front of the case.

CAUTION: Be careful not to damage wiring or scratch interior walls of case with sharp edges of chassis.

To Replace

Install new amplifier assembly by following the above removal steps in a reverse order.

After amplifier has been installed and all connections made, perform the following procedures in the sequence listed:

(1) Perform "Operator Control Adjustment Procedures" as outlined in SECTION II (Operation) of PART 3 in this manual.

(2) Perform procedures under ELECTRICAL SERVICE ADJUSTMENTS instructions as outlined in this section of the manual.

(3) Recalibrate instrument as outlined under "Recorder Calibration" in this section of the manual.

REFERENCE VOLTAGE SUPPLY

To Remove

NOTE: The following instructions are given for the complete removal of the reference voltage supply module from the main frame mechanism. To gain access to the module for servicing procedures alone, refer to topic heading "Reference Voltage Supply Servicing" in this section of the manual.

(1) Swing out frame assemblies from case.

(2) Remove 3 screws that secure the reference supply cover to the rear side of the main frame mechanism. Remove cover.

(3) Unsolder leads from terminal posts on circuit board.

(4) Remove 6 screws from circuit board and remove circuit board.

To Replace

(1) Mount new circuit board to rear of main frame mechanism with 6 screws.

(2) Refer to Figure 3.28 for color-coding identification of leads and connect leads to proper terminal posts on circuit board. Use a low-thermal solder, such as "Kirkson LT" or equivalent.

(3) Replace cover over circuit board and secure cover with 3 screws.

Preliminary Adjustment of Reference Voltage Supply

(1) Turn off CHART DRIVE switch and turn on POWER switch. Allow instrument to warm up.

(2) Connect positive (+) and negative (-) leads of voltmeter (0-10V range) across terminals 6 and 9 respectively of terminal block TB201. Adjust COMP control for 6.5-volt reading on voltmeter. Disconnect voltmeter leads.

(3) Recalibrate instrument as outlined under "Recorder Calibration" in this section of the manual.

BALANCE (SERVO) MOTOR (B301)

NOTE: If the servo response time of the recorder is to be changed, refer to "Changing Full-Scale Response Time" in the MECHANICAL MAINTENANCE section of this manual.

To Remove

(1) Swing out frame assemblies from case. Unlatch chart drive frame from main frame mechanism.

(2) Remove two acorn nuts, and remove cover from terminal block TB401.

(3) Disconnect black, blue, white, yellow, and red motor leads from terminals 5, 6, 7, 8, and 9 respectively on terminal block TB401.

(4) Remove cable clamping screw from motor.

(5) Remove two motor mounting screws and remove motor (with attached pinion) from rear side of main mechanism frame. Remove pinion from motor shaft.

NOTE: On instruments having a 1-, 15-, 20-, or 30- second response speed, the pinion will have to be disengaged and removed from the front side of the main frame before the motor can be withdrawn from the rear side of the main frame.

To Replace

(1) Install new motor to rear of main frame with two mounting screws. Secure cable to motor by replacing the cable clamping screw.

(2) Connect black, blue, white, yellow, and red motor leads to terminals 5, 6, 7, 8, and 9 respectively on terminal block TB401. Reinstall cover over terminal block with two acorn nuts.

(3) Install and secure pinion on motor shaft so that mesh between pinion and bullgear is properly centered. Adjust final position of motor for minimum backlash with no binding. To reduce backlash, loosen mounting screws and turn motor to left and upward. To increase backlash, turn motor to right and upward. Retighten mounting screws and check operation.

PRINT MOTOR (B302)

NOTE: If the print frequency of the recorder is to be changed, refer to "Changing Print Frequency" in the MECHANICAL MAINTENANCE section of this manual.

To Remove

(1) Swing out frame assemblies from case.

(2) Remove two acorn nuts and remove cover from terminal block TB303.

(3) Disconnect blue, black, and red motor leads from terminals 1, 2, and 3 respectively on terminal block TB303.

(4) Remove the driving gear from motor shaft. Remove motor mounting screws. Remove motor.

To Replace

(1) Install new motor with motor mounting screws. Replace driving gear on motor shaft (hub out) so that gear mesh between driven and driving gears is properly centered. Secure driving gear in position.

(2) Connect blue, black, and red motor leads to terminals 1, 2, and 3 respectively on terminal block TB303. Reinstall cover over terminal block with two acorn nuts. Check operation.

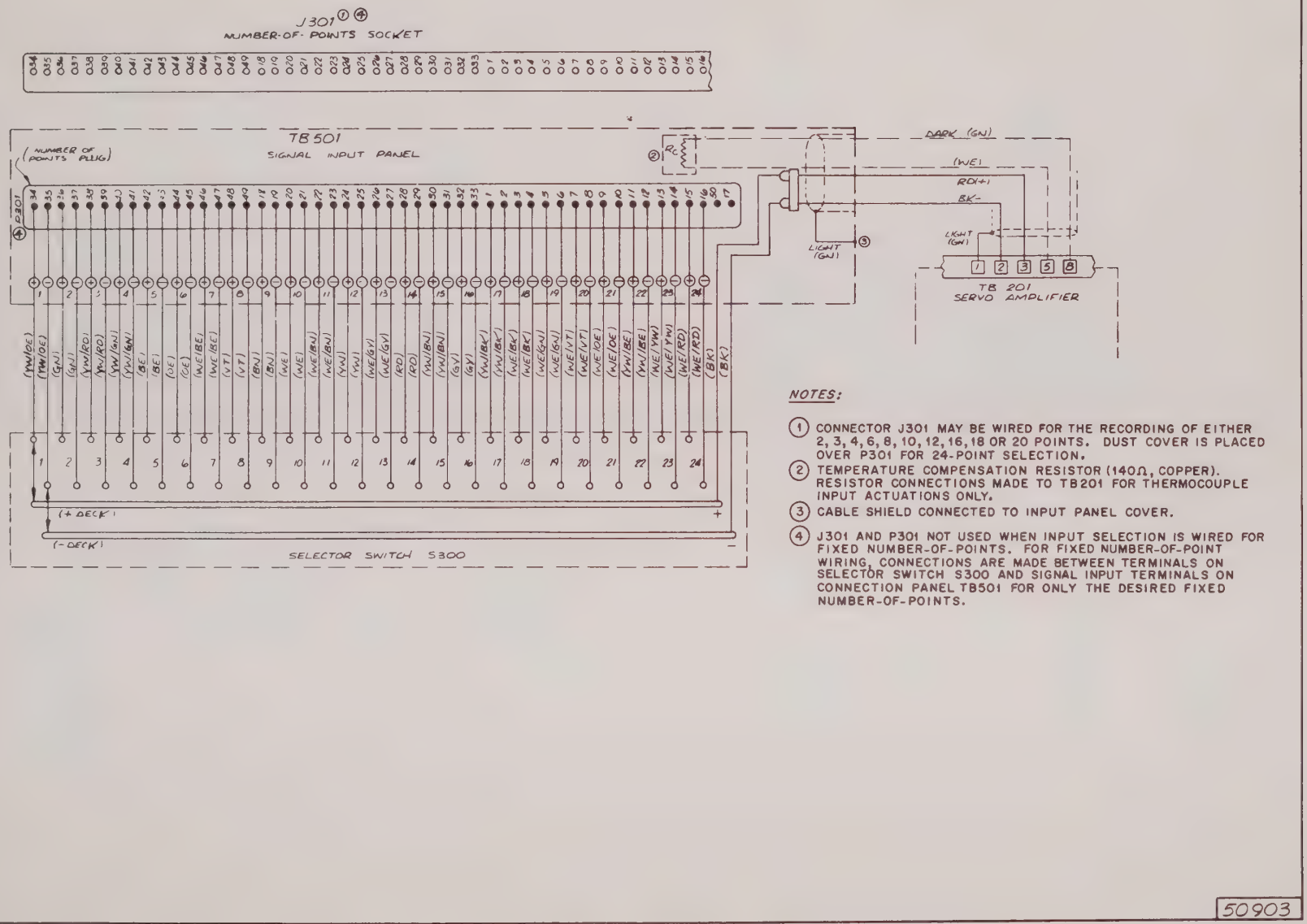
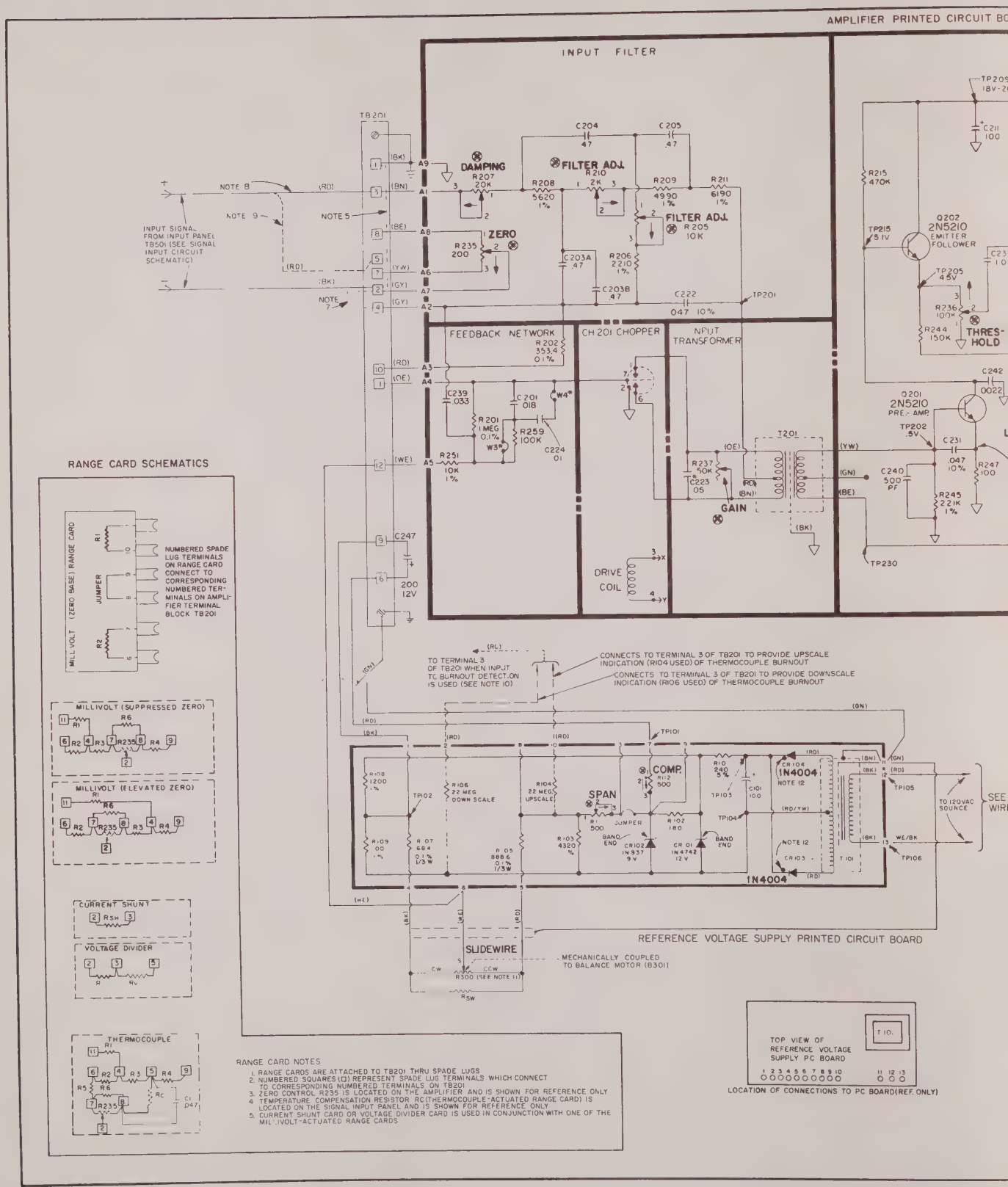
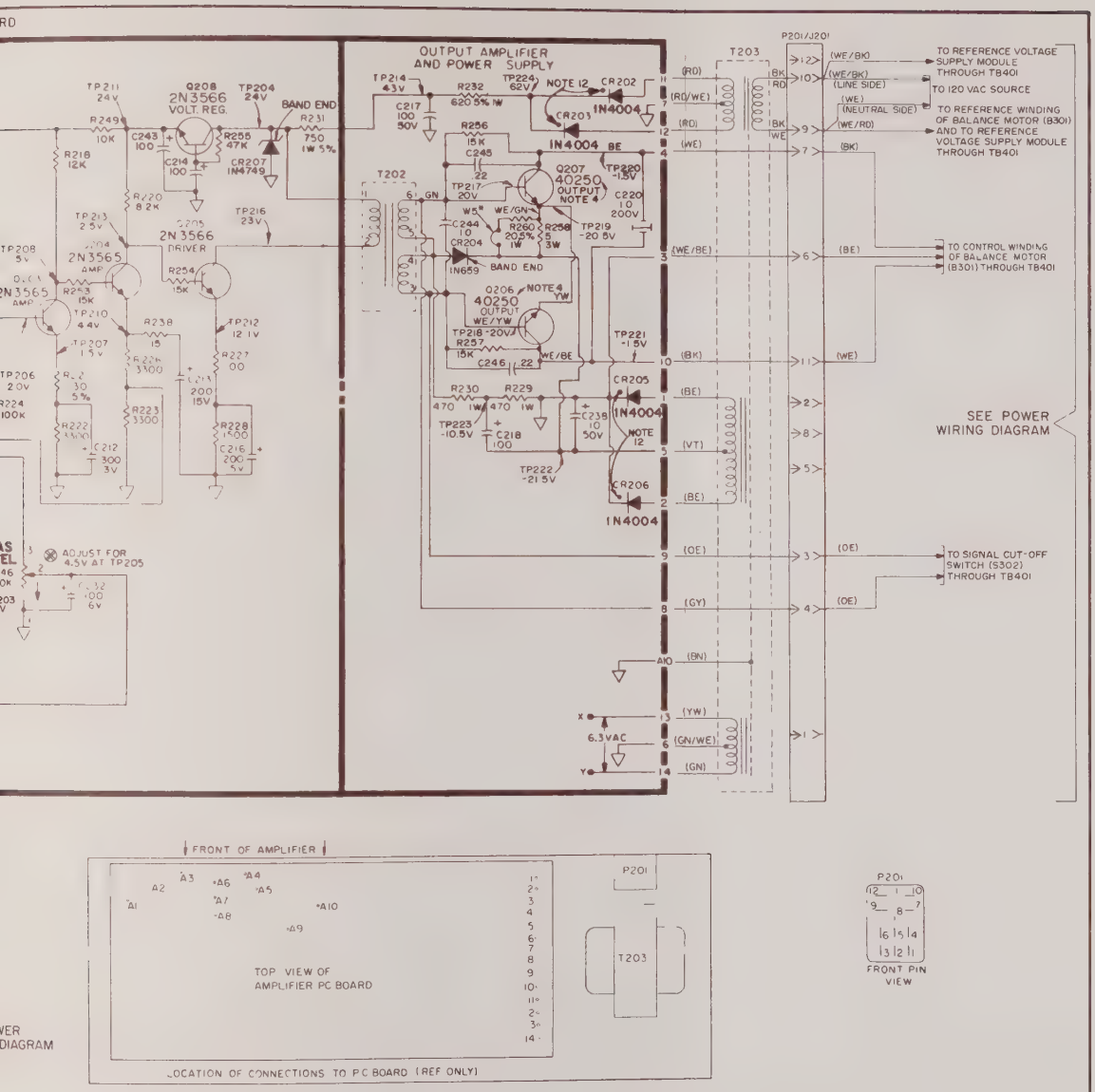

J301 ① ④
NUMBER-OF-POINTS SOCKET
TB501
SIGNAL INPUT PANEL
(NUMBER OF POINTS PLUG)
P301
④
②
Rc
DARK (GN)
(WE)
RD(+)
BK(-)
LIGHT (GN)
③
TB 201
SERVO AMPLIFIER
(+ DECK)
(- DECK)
SELECTOR SWITCH S300
NOTES:
① CONNECTOR J301 MAY BE WIRED FOR THE RECORDING OF EITHER 2, 3, 4, 6, 8, 10, 12, 16, 18 OR 20 POINTS. DUST COVER IS PLACED OVER P301 FOR 24-POINT SELECTION.
② TEMPERATURE COMPENSATION RESISTOR (140Ω, COPPER). RESISTOR CONNECTIONS MADE TO TB201 FOR THERMOCOUPLE INPUT ACTUATIONS ONLY.
③ CABLE SHIELD CONNECTED TO INPUT PANEL COVER.
④ J301 AND P301 NOT USED WHEN INPUT SELECTION IS WIRED FOR FIXED NUMBER-OF-POINTS. FOR FIXED NUMBER-OF-POINT WIRING, CONNECTIONS ARE MADE BETWEEN TERMINALS ON SELECTOR SWITCH S300 AND SIGNAL INPUT TERMINALS ON CONNECTION PANEL TB501 FOR ONLY THE DESIRED FIXED NUMBER-OF-POINTS.
50903

FIGURE 3.27. SIGNAL INPUT CIRCUIT SCHEMATIC.


AMPLIFIER PRINTED CIRCUIT BO
INPUT FILTER
T8201
INPUT SIGNAL FROM INPUT PANEL T8501 (SEE SIGNAL INPUT CIRCUIT SCHEMATIC)
NOTE 8
NOTE 9
NOTE 5
NOTE 7
DAMPING R207 20K
FILTER ADJ R210 2K
FILTER ADJ R205 10K
ZERO R235 200
R208 5620 1%
R209 4990 1%
R211 6190 1%
C204 47
C205 47
C203A .47
C203B .47
R206 2210 1%
C222 047 10%
TP201
FEEDBACK NETWORK
R202 353.4 0.1%
C239 033
C201 018
W4*
R201 1 MEG 0.1%
W3*
R259 100K
C224 01
R251 10K 1%
CH 201 CHOPPER
INPUT TRANSFORMER
T201
R237 50K
C223 05
GAIN
DRIVE COIL
TP230
TP209 18V-2
C211 100
R215 470K
TP215 5.1V
Q202 2N5210 EMITTER FOLLOWER
TP205 4.5V
R236 100K
R244 150K
THRES-HOLD
C242 0022
Q201 2N5210 PRE-AMP
TP202 .5V
C231 .047 10%
R247 100
C240 500 PF
R245 22K 1%
C247 200 12V
RANGE CARD SCHEMATICS
MILLIVOLT (ZERO BASE) RANGE CARD
R1
JUMPER
R2
NUMBERED SPADE LUG TERMINALS ON RANGE CARD CONNECT TO CORRESPONDING NUMBERED TERMINALS ON AMPLIFIER TERMINAL BLOCK T8201
MILLIVOLT (SUPPRESSED ZERO)
MILLIVOLT (ELEVATED ZERO)
CURRENT SHUNT
RSH
VOLTAGE DIVIDER
THERMOCOUPLE
RC
C1 .047
TO TERMINAL 3 OF T8201 WHEN INPUT TC BURNOUT DETECTION IS USED (SEE NOTE 10)
CONNECTS TO TERMINAL 3 OF T8201 TO PROVIDE UPSCALE INDICATION (R104 USED) OF THERMOCOUPLE BURNOUT
CONNECTS TO TERMINAL 3 OF T8201 TO PROVIDE DOWNSCALE INDICATION (R106 USED) OF THERMOCOUPLE BURNOUT
TP101
R108 1200 1%
R106 22 MEG DOWN SCALE
R104 22 MEG UPSCALE
SPAN R1 500
COMP. R112 500
R110 240 5%
C101 100
CR104 1N4004 NOTE 12
TP103
TP104
TP105
TP106
TO 120VAC SOURCE
SEE WIRI
R109 00 1%
R107 684 0.1% 1/3W
R105 8886 0.1% 1/3W
R103 4320 1%
JUMPER
R102 180
BAND END
CR102 IN 937 9V
CR 101 IN 4742 12V
NOTE 12
CR103
T 101
1N4004
WE/BK
SLIDEWIRE
MECHANICALLY COUPLED TO BALANCE MOTOR (B301)
CW
CCW
R300 (SEE NOTE 11)
RSW
REFERENCE VOLTAGE SUPPLY PRINTED CIRCUIT BOARD
TOP VIEW OF REFERENCE VOLTAGE SUPPLY PC BOARD
T 10.
1 2 3 4 5 6 7 8 9 10 11 12 13
LOCATION OF CONNECTIONS TO PC BOARD(REF. ONLY)
RANGE CARD NOTES
1. RANGE CARDS ARE ATTACHED TO T8201 THRU SPADE LUGS
2. NUMBERED SQUARES (□) REPRESENT SPADE LUG TERMINALS WHICH CONNECT TO CORRESPONDING NUMBERED TERMINALS ON T8201
3. ZERO CONTROL R235 IS LOCATED ON THE AMPLIFIER AND IS SHOWN FOR REFERENCE ONLY
4. TEMPERATURE COMPENSATION RESISTOR RC (THERMOCOUPLE-ACTUATED RANGE CARD) IS LOCATED ON THE SIGNAL INPUT PANEL AND IS SHOWN FOR REFERENCE ONLY
5. CURRENT SHUNT CARD OR VOLTAGE DIVIDER CARD IS USED IN CONJUNCTION WITH ONE OF THE MILLIVOLT-ACTUATED RANGE CARDS

FIGURE


OUTPUT AMPLIFIER AND POWER SUPPLY
T203
P201/J201
TO REFERENCE VOLTAGE SUPPLY MODULE THROUGH TB401
TO 120 VAC SOURCE
TO REFERENCE WINDING OF BALANCE MOTOR (B301) AND TO REFERENCE VOLTAGE SUPPLY MODULE THROUGH TB401
TO CONTROL WINDING OF BALANCE MOTOR (B301) THROUGH TB401
SEE POWER WIRING DIAGRAM
TO SIGNAL CUT-OFF SWITCH (S302) THROUGH TB401
Q208 2N3566 VOLT. REG.
Q207 40250 OUTPUT NOTE 4
Q206 40250 OUTPUT WE/YW
Q205 2N3566 DRIVER
Q204 2N3565 AMP
Q203 2N3565 AMP
BAND END
IN4004
IN4749
IN659
6.3VAC
ADJUST FOR 4.5V AT TP205

NOTES:
1. ALL RESISTORS ARE IN OHMS, ±10%, 1/2 WATT, UNLESS OTHERWISE SPECIFIED
2. ALL CAPACITANCE VALUES ARE IN UF UNLESS OTHERWISE SPECIFIED
   UF = MICROFARADS
   PF = PICOFARADS
3. ALL ELECTROLYTIC CAPACITORS ARE RATED AT 25 WVDC UNLESS OTHERWISE SPECIFIED.
4. Q206 AND Q207 ARE MOUNTED ON COMMON HEAT SINK
5. JUMPER IS USED TO CONNECT LO (-) SIDE OF SIGNAL INPUT TO AMPLIFIER CHASSIS GROUND. REMOVE JUMPER WHEN ISOLATED SIGNAL INPUT IS DESIRED
6. ARROWS ON CONTROLS INDICATE CLOCKWISE DIRECTION.
7. JUMPER IS ONLY USED WITH A ZERO-MILLIVOLT-BASE RANGE CARD. JUMPER IS REMOVED WHEN ANY OTHER RANGE IS USED.
8. POSITIVE (+) SIGNAL INPUT LEAD CONNECTS TO TERMINAL 3 OF T8201 FOR FOLLOWING ACTUATIONS:
   A. DC MILLIVOLTS (100 MV AND BELOW MEASURING RANGE)
   B. THERMOCOUPLE
   C. DC CURRENT (CURRENT SHUNT CARD USED IN CONJUNCTION WITH A MILLIVOLTAGE RANGE CARD)
9. POSITIVE (+) SIGNAL INPUT LEAD CONNECTS TO TERMINAL 5 OF T8201 FOR DC VOLTAGE-ACTUATED RANGES (ABOVE 100 MV MEASURING RANGE). DC VOLTAGE-ACTUATED RANGES USE A VOLTAGE DIVIDER CARD IN CONJUNCTION WITH A MILLIVOLTAGE RANGE CARD)
10. WHEN INPUT TC BURNOUT PROTECTION IS PROVIDED, THE INPUT TC BURNOUT CONNECTION TO TERMINAL 3 OF T8201 SHOULD BE REMOVED WHEN A VOLTAGE ACTUATED RANGE (VOLTAGE DIVIDER CARD) IS USED
11. SLIDEWIRE R300 AND SHUNT RESISTOR R_{SW} ARE COMBINED TO FORM A RESISTANCE OF 900Ω ±0.1%
12. TERMINAL IDENTIFICATION DOT
13. TP = TEST POINT
* JUMPERS W3, W4, W5 AND CAPACITOR C223 ADDED ONLY WHEN BALANCE MOTORS NO. 51114 AND NO. 51671 ARE USED

TRANSISTOR TERMINAL GUIDE

SYMBOLS:
- FLOATING SIGNAL GROUND
- SCREWDRIVER ADJUSTMENT
- CHASSIS GROUND

ESTERLINE ANGUS INSTRUMENT CO., INC. INDIANAPOLIS, IND., U.S.A.	
MODEL E1124E SERVO MEASUREMENT LOOP SCHEMATIC (SINGLE-RANGE INSTRUMENTS)	
DR. J.C.	SCALE
CH.	9-73
AP.	54670-4

8. SERVO MEASUREMENT LOOP SCHEMATIC.

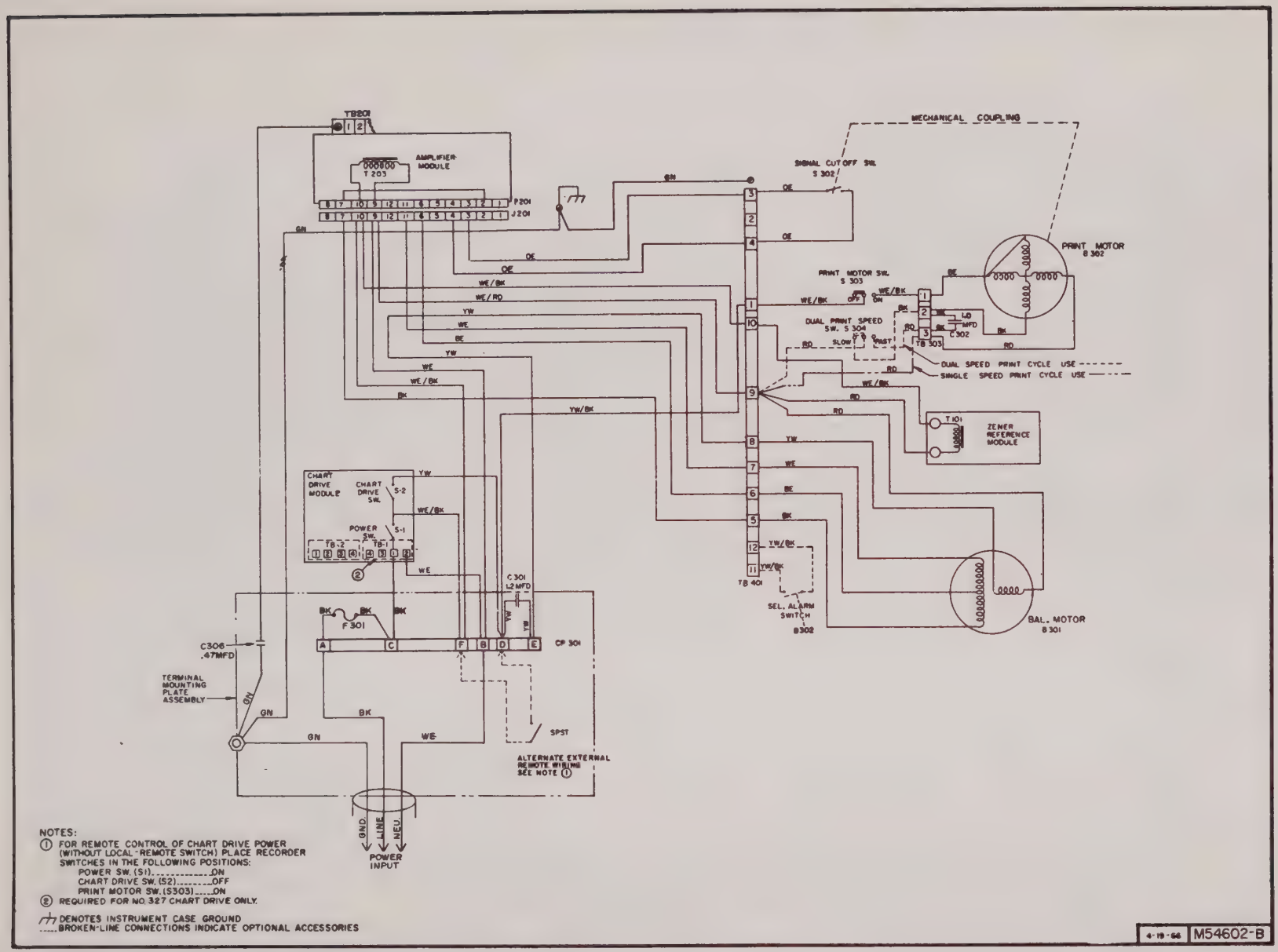
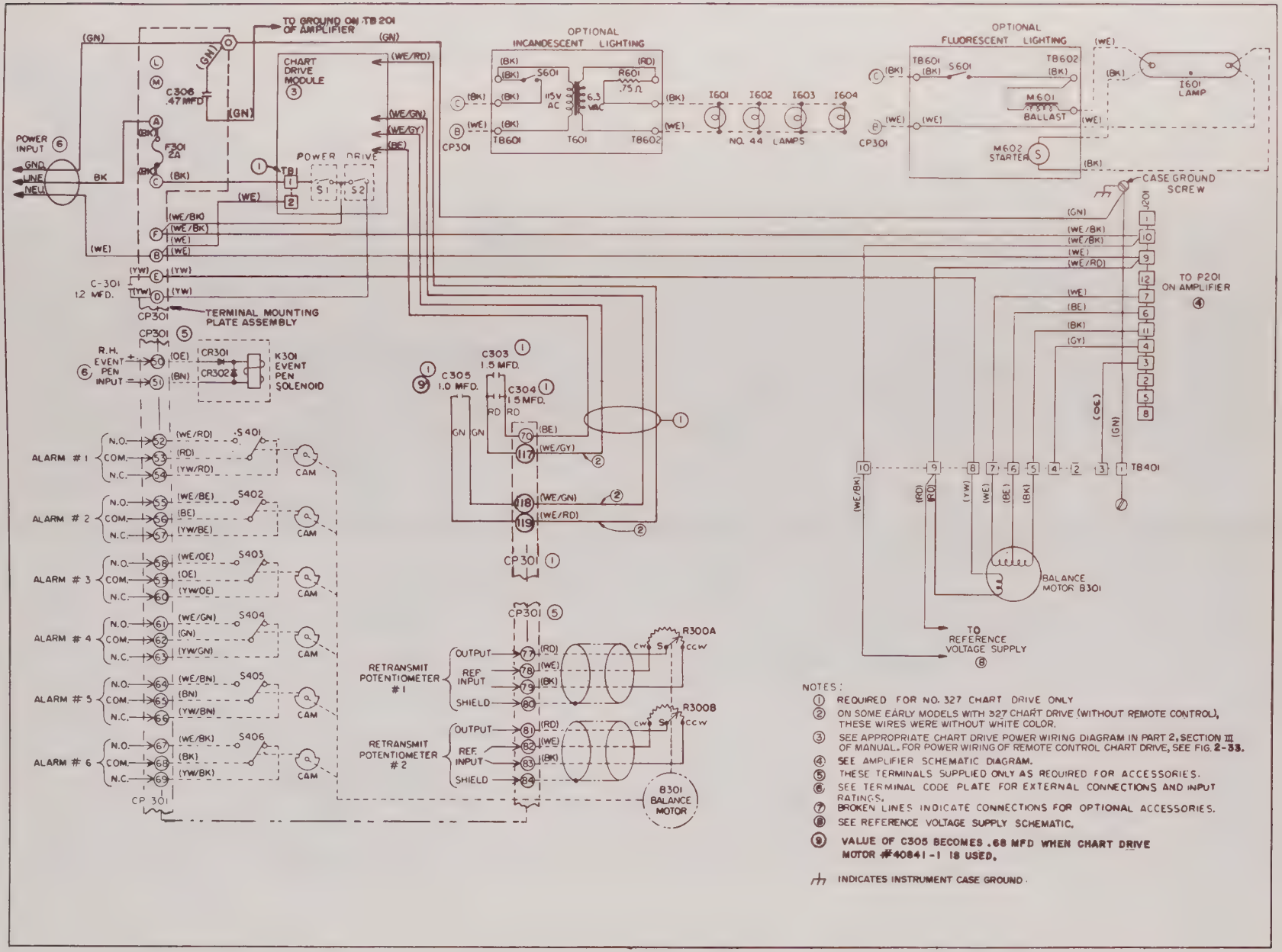


FIGURE 3.29. POWER WIRING DIAGRAM FOR BASIC MODEL E1124E RECORDER.



NOTES:

1. REQUIRED FOR NO. 327 CHART DRIVE ONLY
2. ON SOME EARLY MODELS WITH 327 CHART DRIVE (WITHOUT REMOTE CONTROL), THESE WIRES WERE WITHOUT WHITE COLOR.
3. SEE APPROPRIATE CHART DRIVE POWER WIRING DIAGRAM IN PART 2, SECTION III OF MANUAL. FOR POWER WIRING OF REMOTE CONTROL CHART DRIVE, SEE FIG. 2-33.
4. SEE AMPLIFIER SCHEMATIC DIAGRAM.
5. THESE TERMINALS SUPPLIED ONLY AS REQUIRED FOR ACCESSORIES.
6. SEE TERMINAL CODE PLATE FOR EXTERNAL CONNECTIONS AND INPUT RATINGS.
7. BROKEN LINES INDICATE CONNECTIONS FOR OPTIONAL ACCESSORIES.
8. SEE REFERENCE VOLTAGE SUPPLY SCHEMATIC.
9. VALUE OF C305 BECOMES .68 MFD WHEN CHART DRIVE MOTOR #40841-1 IS USED.

INDICATES INSTRUMENT CASE GROUND.

FIGURE 3.30. POWER AND ACCESSORY WIRING DIAGRAM.

PART 4
ILLUSTRATED PARTS BREAKDOWN

GENERAL

In this part of the manual, the instrument is broken down into a series of major assemblies, or groups of related parts which are illustrated in the various sections. Parts are identified separately in each illustration by an index number which, in turn, is listed in the appropriate parts list for the illustration. Since many parts are illustrated more than once in the Parts Breakdown and index numbers are assigned separately to the illustrations, the same part may not always have the same index number. For this reason, it is necessary to check the "Figure No." column of the Parts List before using it to identify an index number. The "Qty." column refers to the quantity used in the unit shown in the illustration and is not necessarily the total quantity used in the instrument. Commercially-available hardware items, although illustrated, may not always be indexed or have their part numbers listed.

INDENTION SYSTEM

Certain parts in the parts list are indented in either the Description or Part No. column to indicate that they are subassemblies or parts of the next higher assembly listed above them. In the case of double indention, the part is used in an assembly which is in itself a subassembly or attaching part of the part listed above it.

ORDERING INFORMATION

To ensure prompt delivery of the correct parts, always list the model number of the instrument, the serial number, and give a complete description from the breakdown listing as well as the part number. When ordering a part that has not been identified in this breakdown, give the size (dimensions), location in the instrument, and its function. If it is part of an assembly, give the assembly number. If possible, return the part for identification.

CONTENTS

Section I .....Chart Drive Assembly
Section II.....Measuring System Assembly
Section III.....Instrument Case Assembly

SECTION I

CHART DRIVE ASSEMBLY

CHART DRIVE NO. 300

REPLACEMENT PARTS LIST

FIG. 4.1 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50548	300-15C CHART DRIVE ASSY.	1
	50549	300-15A CHART DRIVE ASSY.	
	50550[α]	300-1A CHART DRIVE ASSY.	
	50570[θ]	300-1B CHART DRIVE ASSY.	
1	40475-2[*]	MOTOR (B1), 15 RPM SYNCHRONOUS (300-15C, 300-15A)	1
	40475-3[ω]	MOTOR (B1), 1 RPM SYNCHRONOUS (300-1A, 300-1B)	
2	50557	BRACKET, MOTOR SUPPORT	1
3	51494[+]	CAPACITOR, MOTOR (C1, 1.0 MFD.)	1
4	50541	TRANSMISSION ASSY. (300-15C)	1
	50531	TRANSMISSION ASSY. (300-15A, 300-1A)	
	50521	TRANSMISSION ASSY. (300-1B)	
5	50508	BRACKET, TRANSMISSION SUPPORT	1
6	50091	COUPLING BALL, SHAFT	1
7	50095	COUPLING TUBE, DRIVE	1
7-1	5493	GROOVE PIN, COUPLING	1
8	50503	PLATE ASSY., MOUNTING	1
9	400330	SWITCH, CHART DRIVE (S2, SPST)	1
10	50482	BRACKET, CHART DRIVE SWITCH	1
11	50608-1	TERMINAL STRIP, CERAMIC (TB2)	1
12	50397	COVER, CERAMIC TERMINAL STRIP	1
13	400330	SWITCH, POWER (S1, SPST)	1
14	50588	BRACKET, POWER SWITCH	1
18	50642[π]	CABLE ASSY., TRANSMISSION (WITHOUT REMOTE CONTROL)	1
	50644[6]	CABLE ASSY., TRANSMISSION (WITH REMOTE CONTROL)	
	50671-1[#]	CABLE ASSY., TRANSMISSION (REMOTE WITH INTERNAL MODE SWITCH)	
19	50604	PANEL, FRONT CONTROL (WITHOUT INTERNAL MODE SWITCH)	1
	50659	PANEL, FRONT CONTROL (USED WITH INTERNAL MODE SWITCH)	
20	12448	GEAR, MANUAL CHANGE (18T, GOLD)	1
	12454	GEAR, MANUAL CHANGE (30T, GREEN)	1
	12460	GEAR, MANUAL CHANGE (45T, RED)	2
	12466	GEAR, MANUAL CHANGE (60T, GREEN)	1
	12472	GEAR, MANUAL CHANGE (72T, GOLD)	1
21	12476	NUT, KNURLED CHANGE GEAR	2
	50617	SWITCH, INTERNAL MODE (S3, SPDT); NOT ILLUSTRATED (USED WITH REMOTE CONTROL)	1

[α] PART NO. BECOMES 50678 (FOR LOCAL CONTROL) OR 50678-1 (FOR REMOTE CONTROL) OR 50688 (FOR REMOTE CONTROL WITH INTERNAL MODE SWITCH) WHEN MOTOR PART NO. 73B76-1 IS USED.

[θ] PART NO. BECOMES 50679 (FOR LOCAL CONTROL) OR 50679-1 (FOR REMOTE CONTROL) OR 50689 (FOR REMOTE CONTROL WITH INTERNAL MODE SWITCH) WHEN MOTOR PART NO. 76B76-1 IS USED.

[*] PART NO. 40481-1 USED IN LATER PRODUCTION UNITS.

[ω] PART NO. 73B76-1 USED IN LATER PRODUCTION UNITS.

[+] CAPACITOR PART NO. 40481-1C (.68 MFD) USED WITH MOTOR PART NO. 40481-1. CAPACITOR (C1) NOT USED WITH MOTOR PART NO. 73B76-1.

[π] PART NO. BECOMES 50683 WHEN MOTOR PART NO. 73B76-1 IS USED.

[6] PART NO. BECOMES 50686 WHEN MOTOR PART NO. 73B76-1 IS USED.

[#] PART NO. BECOMES 50687-1 WHEN MOTOR PART NO. 73B76-1 IS USED.

CHART DRIVE NO. 318

REPLACEMENT PARTS LIST

FIG. 4.2 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50502-60	318-60 Chart Drive Assy. (2-Speed)	1
	50502-30	318-30 Chart Drive Assy. (2-Speed)	
	50502-15	318-15 Chart Drive Assy. (2-Speed)	
	50502-10	318-10 Chart Drive Assy. (2-Speed)	
	50502-6	318-6 Chart Drive Assy. (2-Speed)	
1	40475-2*	Motor (B1), 15 RPM Synchronous	1
2	50558-1	Spacer, Motor Support	1
3	50557	Bracket, Motor Support	1
4	51494+	Capacitor, Motor (C1, 1.0 Mfd.)	1
5	50404	Gear Box, Dual-Speed (60:1)	1
	50403	Gear Box, Dual-Speed (30:1)	
	50402	Gear Box, Dual-Speed (15:1)	
	50401	Gear Box, Dual-Speed (10:1)	
	50400	Gear Box, Dual-Speed (6:1)	
6	50551	Transmission Assy.	1
7	50508	Bracket, Transmission Support	1
8	50091	Coupling Ball, Shaft	1
9	50095	Coupling Tube, Drive	1
9-1	5493	Groove Pin, Coupling	1
10	50504	Plate Assy., Mounting	1
11	400330	Switch, Chart Drive (S2, SPST)	1
12	50581	Bracket, Chart Drive Switch	1
13	50608-1	Terminal Strip, Ceramic (TB2)	1
14	50485	Cover, Ceramic Terminal Strip	1
15	400330	Switch, Power (S1, SPST)	1
16	50588	Bracket, Power Switch	1
17	50617	Switch, HR/MIN (S3, SPDT)	1
18	50599	Bracket, HR/MIN Switch	1
22	50638	Cable Assy., Transmission (Without Remote Control)	1
	50640	Cable Assy., Transmission (With Remote Control)	
	50673-1	Cable Assy., Transmission (Remote With Internal Mode Switch)	1
23	50465	Panel, Front Control (Without Internal Mode Switch)	1
	50660	Panel, Front Control (Used With Internal Mode Switch)	
24	12488	Gear, Manual Change (18T Gold)	1
	12454	Gear, Manual Change (30T Green)	1
	12460	Gear, Manual Change (45T Red)	2
	12466	Gear, Manual Change (60T Green)	1
	12472	Gear, Manual Change (72T Gold)	1
25	12476	Nut, Knurled Change Gear	2
	43541	Switch, Internal Mode (S4, 4PDT), Not Illustrated (Used with Remote Control)	1

*Part No. 40481-1 used in later production units.
+Capacitor Part No. 40481-1C (.68 MFD) used with motor Part No. 40481-1.

CHART DRIVE NO. 303

REPLACEMENT PARTS LIST

FIG. 4.3 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50475-60	303-60 CHART DRIVE ASSY. (IN OR CM/HR)	1
	50475-30	303-30 CHART DRIVE ASSY. (IN OR CM/HR x 2)	
	50475-15	303-15 CHART DRIVE ASSY. (IN OR CM/HR x 4)	
	50475-10	303-10 CHART DRIVE ASSY. (IN OR CM/HR x 6)	
	50475-6	303-6 CHART DRIVE ASSY. (IN OR CM/HR x 10)	
1	40475-2θ	MOTOR (B1), 15-RPM SYNCHRONOUS	1
2	50470	GEAR BOX, SINGLE-SPEED (IN OR CM/HR)	1
	50471	GEAR BOX, SINGLE-SPEED (IN OR CM/HR x 2)	
	50472	GEAR BOX, SINGLE-SPEED (IN OR CM/HR x 4)	
	50473	GEAR BOX, SINGLE-SPEED (IN OR CM/HR x 6)	
	50474	GEAR BOX, SINGLE-SPEED (IN OR CM/HR x 10)	
3	50561	TRANSMISSION, FIVE-SPEED	1
4	400330	SWITCH, CHART DRIVE (S2, SPST)	1
5	400330	SWITCH, POWER (S1, SPST)	1
6	50558-1	SPACER, MOTOR SUPPORT	1
7	50557	BRACKET, MOTOR SUPPORT	1
8	50608-1	TERMINAL STRIP, CERAMIC (TB2)	1
9	50485	COVER, CERAMIC TERMINAL STRIP	1
10	50622	SPRING, CAM TENSIONING	4
11	50464	KNOB, INCHES SELECTOR (FOR 1/2 IN-BASE DRIVE)	1
	50598	KNOB, INCHES SELECTOR (FOR 3/4 IN-BASE DRIVE)	
	50478	KNOB, CENTIMETERS SELECTOR (FOR METRIC DRIVE)	
12	50508	BRACKET, TRANSMISSION SUPPORT	1
13	50091	COUPLING BALL, SHAFT	1
14	50095-2	COUPLING TUBE, DRIVE	1
14-1	5493 +	GROOVE PIN, COUPLING	1
15	51494	CAPACITOR, MOTOR (C1, 1.0 MFD.)	1
19	50524	PLATE ASSY., MOUNTING	1
20	50588	BRACKET, POWER SWITCH	1
21	50581	BRACKET, CHART DRIVE SWITCH	1
22	50642	CABLE ASSY., TRANSMISSION (WITHOUT REMOTE CONTROL)	1
	50644	CABLE ASSY., TRANSMISSION (WITH REMOTE CONTROL)	
	50671-1	CABLE ASSY., TRANSMISSION (REMOTE WITH INTERNAL MODE SWITCH)	
23	50457	PANEL, FRONT CONTROL (303-60 IN-BASE DRIVES)	1
	50458	PANEL, FRONT CONTROL (303-30 IN-BASE DRIVES)	
	50459	PANEL, FRONT CONTROL (303-15 IN-BASE DRIVES)	
	50460	PANEL, FRONT CONTROL (303-10 IN-BASE DRIVES)	
	50461	PANEL, FRONT CONTROL (303-6 IN-BASE DRIVES)	
	50362	PANEL, FRONT CONTROL (303-60 METRIC DRIVES)	
	50361	PANEL, FRONT CONTROL (303-30 METRIC DRIVES)	
	50360	PANEL, FRONT CONTROL (303-15 METRIC DRIVES)	
	50359	PANEL, FRONT CONTROL (303-10 METRIC DRIVES)	
	50358	PANEL, FRONT CONTROL (303-6 METRIC DRIVES)	
	50661-*	PANEL, FRONT CONTROL (FOR INTERNAL MODE SWITCH)	
	50617	SWITCH, INTERNAL MODE (S3, SPDT); NOT ILLUSTRATED (USED WITH REMOTE CONTROL)	1

*SPECIFY UNITS OF FEED RATE.
θPART NO. 40481-1 USED IN LATER PRODUCTION UNITS.
+CAPACITOR PART NO. 40481-1C (.68 MFD) USED WITH MOTOR PART NO. 40481-1.

CHART DRIVE NO. 309

REPLACEMENT PARTS LIST

FIG. 4.4 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50476	309 Chart Drive Assy. (IN or CM/MIN)	1
1	40475-2θ	Motor (B1), 15 RPM Synchronous	1
2	50479	Gear Box, Single-Speed (IN or CM/MIN)	1
3	50561	Transmission, Five-Speed	1
4	400330	Switch, Chart Drive (S2, SPST)	1
5	400330	Switch, Power (S1, SPST)	1
6	50558-1	Spacer, Motor Support	1
7	50557	Bracket, Motor Support	1
8	50608-1	Terminal Strip, Ceramic (TB2)	1
9	50485	Cover, Ceramic Terminal Strip	1
10	50622	Spring, Cam Tensioning	4
11	50464	Knob, Inches Selector (For IN-Base Drive)	1
	50473	Knob, Centimeters Selector (For Metric Drive)	
12	50508	Bracket, Transmission Support	1
13	50091	Coupling Ball, Shaft	1
14	50095-2	Coupling Tube, Drive	1
14-1	5493	Groove Pin, Coupling	1
15	51494+	Capacitor, Motor (C1, 1.0 Mfd.)	1
19	50524	Plate Assy., Mounting	1
20	50588	Bracket, Power Switch	1
21	50581	Bracket, Chart Drive Switch	1
22	50642	Cable Assy., Transmission (Without Remote Control)	1
	50644	Cable Assy., Transmission (With Remote Control)	
	50671-1	Cable Assy., Transmission (Remote With Internal Mode Switch)	
23	50462	Panel, Front Control (Inch-Based Drives)	1
	50357	Panel, Front Control (Metric Drives)	
	50661-*	Panel, Front Control (For Internal Mode Switch)	
	50617	Switch, Internal Mode (S3, SPDT); Not Illustrated (Used With Remote Control)	1

*Specify units of feed rate.
θPart No. 40481-1 used in later production units.
+Capacitor Part No. 40481-1C (.68 MFD) used with motor Part No. 40481-1.

CHART DRIVE NO. 321

REPLACEMENT PARTS LIST

FIG. 4.5 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50501-60	321-60 Chart Drive Assy., 10-Speed (IN or CM/HR)	1
	50501-30	321-30 Chart Drive Assy., 10-Speed (IN or CM/HR x 2)	
	50501-15	321-15 Chart Drive Assy., 10-Speed (IN or CM/HR x 4)	
	50501-10	321-10 Chart Drive Assy., 10-Speed (IN or CM/HR x 6)	
	50501-6 θ	321-6 Chart Drive Assy., 10-Speed (IN or CM/HR x 10)	
1	40475-2 θ	Motor (B1), 15 RPM Synchronous	1
2	50560	Gear Box, Dual-Speed (IN or CM/HR)	1
	50530	Gear Box, Dual-Speed (IN or CM/HR x 2)	
	50515	Gear Box, Dual-Speed (IN or CM/HR x 4)	
	50510	Gear Box, Dual-Speed (IN or CM/HR x 6)	
	50506	Gear Box, Dual-Speed (IN or CM/HR x 10	
3	50561	Transmission, Five-Speed	1
4	400330	Switch, Chart Drive (S2, SPST)	1
5	400330	Switch, Power (S1, SPST)	1
6	50558	Spacer, Motor Support	1
7	50557	Bracket, Motor Support	1
8	50608-1	Terminal Strip, Ceramic (TB2)	1
9	50485	Cover, Ceramic Terminal Strip	1
10	50617	Switch, HR-MIN (S3, SPDT)	1
11	50622	Spring, Cam Tensioning	4
12	50464	Knob, Inches Selector (1/2 IN-Base Drive)	1
	50598	Knob, Inches Selector (3/4 IN-Base Drive)	
	50478	Knob, Centimeters Selector (Metric Drive)	
13	50508	Bracket, Transmission Support	1
14	50091	Coupling Ball, Shaft	1
15	50095-2	Coupling Tube, Drive	1
15-1	5493 +	Groove Pin, Coupling	1
16	51494	Capacitor, Motor (C1, 1.0 Mfd.)	1
20	50588	Bracket, Power Switch	1
21	50581	Bracket, Chart Drive Switch	1
22	50638	Cable Assy., Transmission (Without Remote Control)	1
	50640	Cable Assy., Transmission (With Remote Control)	
	50673-1	Cable Assy., Transmission (Remote With Internal Mode Switch)	
23	50599	Bracket, Switch (HR-MIN)	1
24	50504	Plate Assy., Mounting	1
25	50628	Panel, Front Control (321-60 IN-Base Drives)	1
	50629	Panel, Front Control (321-30 IN-Based Drives)	
	50630	Panel, Front Control (321-15 IN-Based Drives)	
	50631	Panel, Front Control (321-10 IN-Based Drives)	
	50632	Panel, Front Control (321-6 IN-Based Drives)	
	50367	Panel, Front Control (321-60 Metric Drives)	
	50366	Panel, Front Control (321-30 Metric Drives)	
	50365	Panel, Front Control (321-15 Metric Drives)	
	50364	Panel, Front Control (321-10 Metric Drives)	
	50363	Panel, Front Control (321-6 Metric Drives)	
	50662-*	Panel, Front Control (For Internal Mode Switch)	
	43541	Switch, Internal Mode (S4, 4PDT); Not Illustrated (Used With Remote Control)	1

*Specify units of feed rate.
θPart No. 40481-1 used in later production units.
+Capacitor Part No. 40481-1C (.68 MFD) used with motor Part No. 40481-1.

CHART DRIVE NO. 327

REPLACEMENT PARTS LIST

FIG. 4.6 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50500	327 Chart Drive Assy., 15-Speed	1
1	40475-2[θ]	Motor (B1), 15 RPM Synchronous	1
2	41360-1	Motor (B2), 120 RPM Synchronous	1
3	50571	Transmission Assy.	1
4	50560	Gear Box, Dual-Speed	1
5	50558	Spacer, Motor Support	1
6	50557	Bracket Assy., Motor Support	1
7	400330	Switch, Chart Drive (S2, SPST)	1
8	400330	Switch, Power (S1, SPST)	1
9	50595	Switch Assy., Control (S3, HR-MIN-SEC)	1
10	50463	Knob, Selector Switch (HR-MIN-SEC)	1
11	50608	Terminal Strip, Ceramic (TB2)	1
12	50485	Cover, Ceramic Terminal Strip	1
13	50622	Spring, Cam Tensioning	4
14	50464	Knob, Inches Selector (1/2 IN-Base Drive)	1
	50598	Knob, Inches Selector (3/4 IN-Base Drive)	
	50478	Knob, Centimeters Selector (Metric Drive)	
15	50508	Bracket Assy., Transmission Support	1
16	50091	Coupling Ball, Shaft	1
17	50095-2	Coupling Tube, Drive	1
17-1	5493	Groove Pin, Coupling	1
18	50609-1	Terminal Strip (TB1)	1
19	50606	Cover, Terminal Strip	1
20	50605	Shield, Terminal Strip	1
21	50588	Bracket, Power Switch	1
22	50581	Bracket, Chart Drive Switch	1
23	50634	Cable Assy., Transmission (Without Remote Control)	1
	50636	Cable Assy., Transmission (With Remote Control)	
24	50505	Plate Assy., Mounting	1
25	50633	Panel, Front Control (Inch-Based Drives)	1
	50368	Panel, Front Control (Metric Drives)	
	51494[+]	Capacitor (1.0 MFD), For Motor B1; Not Illustrated; Located on Terminal Mounting Plate Assembly in Case.	1
	40534	Capacitor (1.5 MFD); For Motor B2; Not Illustrated; Located on Terminal Mounting Plate Assembly in Case.	2
	43541	Switch, Internal Mode (S4, 4PDT); Not Illustrated; (Used With Remote Control; Located on Terminal Mounting Plate Assembly in Case).	1

[θ]Part No. 40481-1 used in later production units.
[+]Capacitor Part No. 40481-1C (.68 MFD) used with motor Part No. 40481-1.

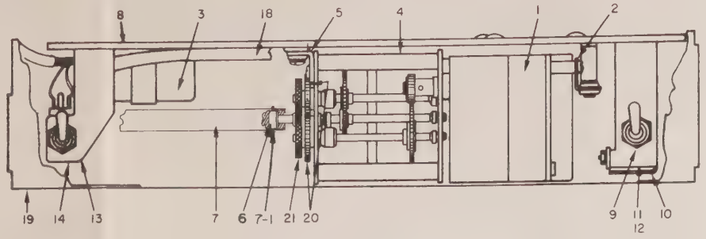


FIGURE 4.1. NO. 300 SINGLE-SPEED CHART DRIVE MODULES.

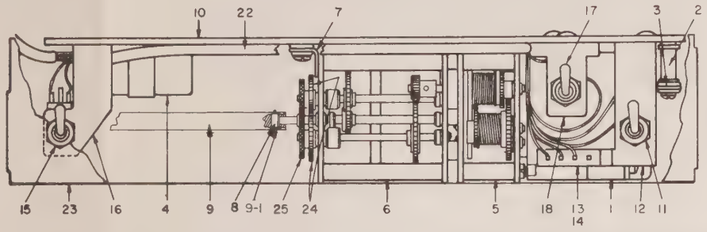


FIGURE 4.2. NO. 318 DUAL-SPEED CHART DRIVE MODULES.

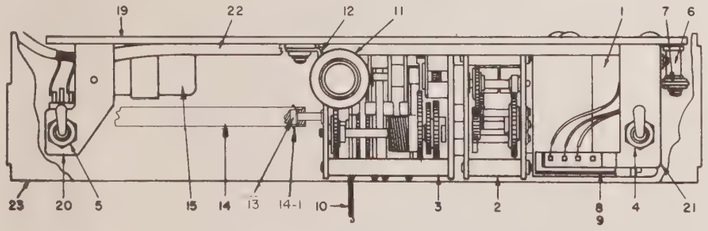


FIGURE 4.3. NO. 303 FIVE-SPEED CHART DRIVE MODULES.

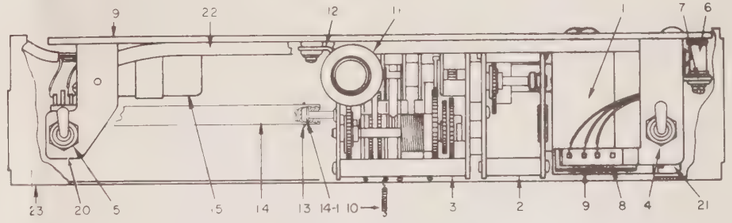


FIGURE 4.4. NO. 309 FIVE-SPEED CHART DRIVE MODULES.

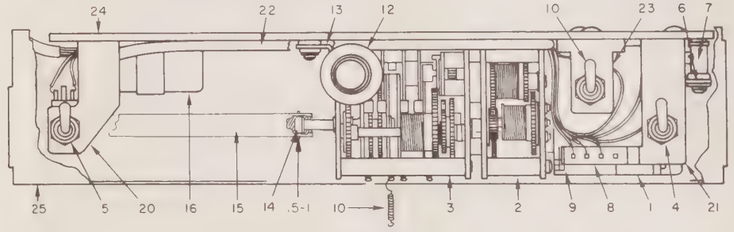


FIGURE 4.5. NO. 321 TEN-SPEED CHART DRIVE MODULES.

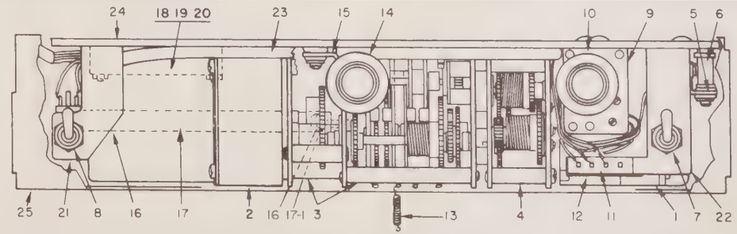


FIGURE 4.6. NO. 327 FIFTEEN-SPEED CHART DRIVE MODULES.

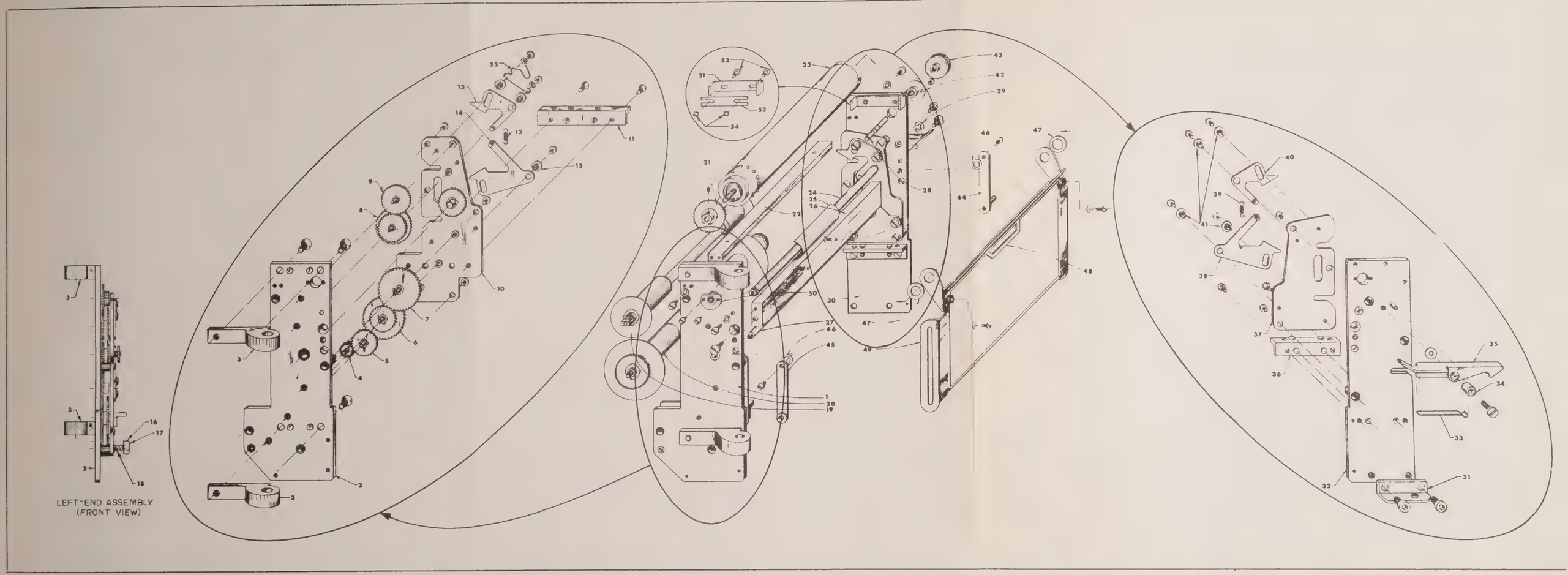


FIGURE 4.7. CHART TRANSPORT EXPLODED VIEW

CHART TRANSPORT REPLACEMENT PARTS LIST

FIG. 4.7 INDEX NO.	PART NO.	DESCRIPTION	QTY.
	50310-50	UNIVERSAL CHART TRANSPORT SUBASSY. (1/2-IN. BASE, 50-CYCLE DRIVE)	1
	50310-60	UNIVERSAL CHART TRANSPORT SUBASSY. (1/2-IN. BASE, 60-CYCLE DRIVE)	
	50311-50	UNIVERSAL CHART TRANSPORT SUBASSY. (3/4-IN. BASE, 50-CYCLE DRIVE)	
	50311-60	UNIVERSAL CHART TRANSPORT SUBASSY. (3/4-IN. BASE, 60-CYCLE DRIVE)	
	50312-50	UNIVERSAL CHART TRANSPORT SUBASSY. (1.25-CM BASE, 50-CYCLE DRIVE)	
	50312-60	UNIVERSAL CHART TRANSPORT SUBASSY. (1.25-CM BASE, 60-CYCLE DRIVE)	
1	50276	END ASSY., LEFT (1.25-CM OR 1/2-IN. BASE, 50-CYCLE DRIVE)	1
	50278	END ASSY., LEFT (1.25-CM OR 1/2-IN. BASE, 60-CYCLE DRIVE)	
	50277	END ASSY., LEFT (3/4-IN. BASE, 50-CYCLE DRIVE)	
	50279	END ASSY., LEFT (3/4-IN. BASE, 60-CYCLE DRIVE)	
2	50269	SIDE PLATE ASSY., LEFT	1
3	50018	HINGE	2
4	50039	INPUT SHAFT ASSY. (FOR 1/2-IN. OR 1.25-CM BASED 50/60-CYCLE DRIVE)	1
	50078	INPUT SHAFT ASSY. (FOR 3/4-IN. BASED 50/60-CYCLE DRIVE)	1
5	50227	1ST WHEEL SHAFT ASSY. (FOR 1/2-IN. OR 1.25-CM BASED 50-CYCLE DRIVE)	1
	50045	1ST WHEEL SHAFT ASSY. (FOR 1/2-IN. OR 1.25-CM BASED 60-CYCLE DRIVE)	1
	50084	1ST WHEEL SHAF. ASSY. (FOR 3/4-IN. BASED 50-CYCLE DRIVE)	1
	50081	1ST WHEEL SHAFT ASSY. (FOR 3/4-IN. BASED 60-CYCLE DRIVE)	1
6	50229	2ND WHEEL SHAFT ASSY. (FOR 1.25-CM, 1/2 AND 3/4-IN. BASED 50-CYCLE DRIVES)	1
	50049	2ND WHEEL SHAFT ASSY. (FOR 1.25-CM, 1/2 AND 3/4-IN. BASED 60-CYCLE DRIVES)	1
7	50052	3RD WHEEL SHAFT ASSY. (ALL DRIVES)	1
8	50065	5TH WHEEL SHAFT ASSY. (ALL DRIVES)	1
9	50069	6TH WHEEL SHAFT ASSY. (ALL DRIVES)	1
10	50275	STANDOFF PLATE ASSY., LEFT (WITH GEARS FOR ALL DRIVES)	1
11	50303	BRACKET	1
12	17064	TENSION SPRING	1
13	50292	SUPPLY ROLL LEVER ASSY., LEFT	1
14	50294	REROLL LEVER ASSY., LEFT	1
15	12440	BUSHING, REROLL AND SUPPLY CLIPS	4
16	5493	PIN	1
17	50091	COUPLER	1
18	17358	SPRING	1
19	50181	SUPPLY ROLL STICK ASSY.	1
20	50180	REROLL STICK ASSY.	1
21	50036	GEAR AND HUB ASSY. (DRIVE ROLL)	1
22	50249	TIE BAR	1
23	50020	TIMING ROLL ASSY. (DRIVE ROLL FOR INCH-BASED DRIVES)	1
	50020-M	TIMING ROLL ASSY. (DRIVE ROLL FOR METRIC DRIVES)	1

CHART TRANSPORT REPLACEMENT PARTS LIST (CONT'D.)

FIG. 4.7 INDEX NO.	PART NO.	DESCRIPTION	QTY.
24	50253	Tie Rod	1
25	50252	Chart Guide	1
26	50250	Tie Bar (Lower)	1
27	50105	Platen Tie Rod (Writing Table Rod)	1
28	50032	Shaft, Timing Roll (Right)	1
29	43006	"E" Ring, Retainer	1
30	50288	End Assy. (Right)	1
31	50299	Shipping Bracket	1
32	50282	Side Plate Assy. (Right)	1
33	50198	Latch Spring	1
34	50197	Latch Pivot	1
35	50196	Latch	1
36	50304	Bracket	1
37	50284	Stand-off Plate (Right)	1
38	50289	Reroll Lever Assy. (Right)	1
39	17064	Tension Spring	1
40	50293	Supply Roll Lever Assy. (Right)	1
41	12440	Bushing, Reroll Clip	4
42	40058	Drive Roll Bushing Assy. (Right Hand)	1
43	12084-1	Set Knob	1
44	50113	Platen Lever Assy. (Right)	1
45	50114	Platen Lever Assy. (Left)	1
46	50306	Washer	2
47	50307	Washer	2
48	50099	Tear-off Bar	1
49	50112	Platen	1
50	50130	Bearing Assy., Drive Roll	1
51	52557	Slide, Pen Lifter	1
52	52555	Spring, Pen Lifter	1
53	52554	Retaining Pin, Pen Lifter	2
54	ND40140-5	"E" Ring	2
55	50285	Guide Finger	1

SECTION II
MEASURING SYSTEM ASSEMBLY
FOR
MODEL E1124E

MAIN FRAME MECHANISM
REPLACEMENT PARTS LIST

FIG. 4.8 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	51001	Mechanism Assembly (Complete)	1
A1	51113	Sideplate Assembly, Right	1
A3	50302	Bracket, Chart Drive Support	1
A4	55018	Latch Lever, Frame	1
	50197	Pivot, Latch	1
	50198	Spring, Latch	1
A5	50206	Roller, Frame Support	1
A6	50205	Bearing Post, Roller	1
A7	50299	Block, Shipping	2
A12	54167	Angle Bracket, Sideplate	1
A13	51347	Sideplate Assembly, Left	1
A15	54007-3	Hinge Block, Frame (Upper)	1
A16	54007	Hinge Block, Frame (Lower)	1
A17	51348	Backplate Assembly	1
A18	406580-1	Cable, Servo (Woven Stainless Steel)	1
†A21	ND40140-7	"E" Ring	1
†A21-1	54023	Shaft, Idler Gear	1
†A22	54025	Gear, Idler	1
A23	54133	Hub Assembly (With Stop Lever)	1
A23-1	54134	Lever, Stop	1
A23-2	54135	Bracket, Overtravel Stop	1
A23-3	54377	Gear, Anti-Backlash (Used Only for 1/2-Second Response Speed)	1
A23-4	6336	Spring (Used Only for 1/2-Second Response Speed)	2
A24	*	Bullgear and Slip-Clutch Mechanism:	1
	54375	1/2- and 4-Second Response Times (324 Teeth)	
	54276-B	1- and 20-Second Response Times (252 Teeth)	
	54277-B	15-Second Response Time (232 Teeth)	
	54278-B	30-Second Response Time (280 Teeth)	
A24-1		Bullgear and Hub Assembly:	1
	54376	1/2- and 4-Second Response Times (324 Teeth)	
	54280	1- and 20-Second Response Times (252 Teeth)	
	54281	15-Second Response Time (232 Teeth)	
	54282	30-Second Response Time (280 Teeth)	
	54288	Slip-Clutch Assembly	1
A24-2	54289	Race, Bearing	1
A24-3	54291	"O" Rings	2
A24-4	54290	Plate, Pressure	1
A24-5	ND40213-73	Screw, Clutch Adjusting	3
A25	*	Pinion, Balancing Motor:	1
	54386	1/2-Second Response Time (36 Teeth)	
	54101	1- and 20-Second Response Times (108 Teeth)	
	54102	15-Second Response Time (128 Teeth)	
	54103	30-Second Response Time (80 Teeth)	
	54104	4-Second Response Time (36 Teeth)	

* Refer to Instrument Data Sheet.
† Used only when instrument is optionally equipped with "Alarms".

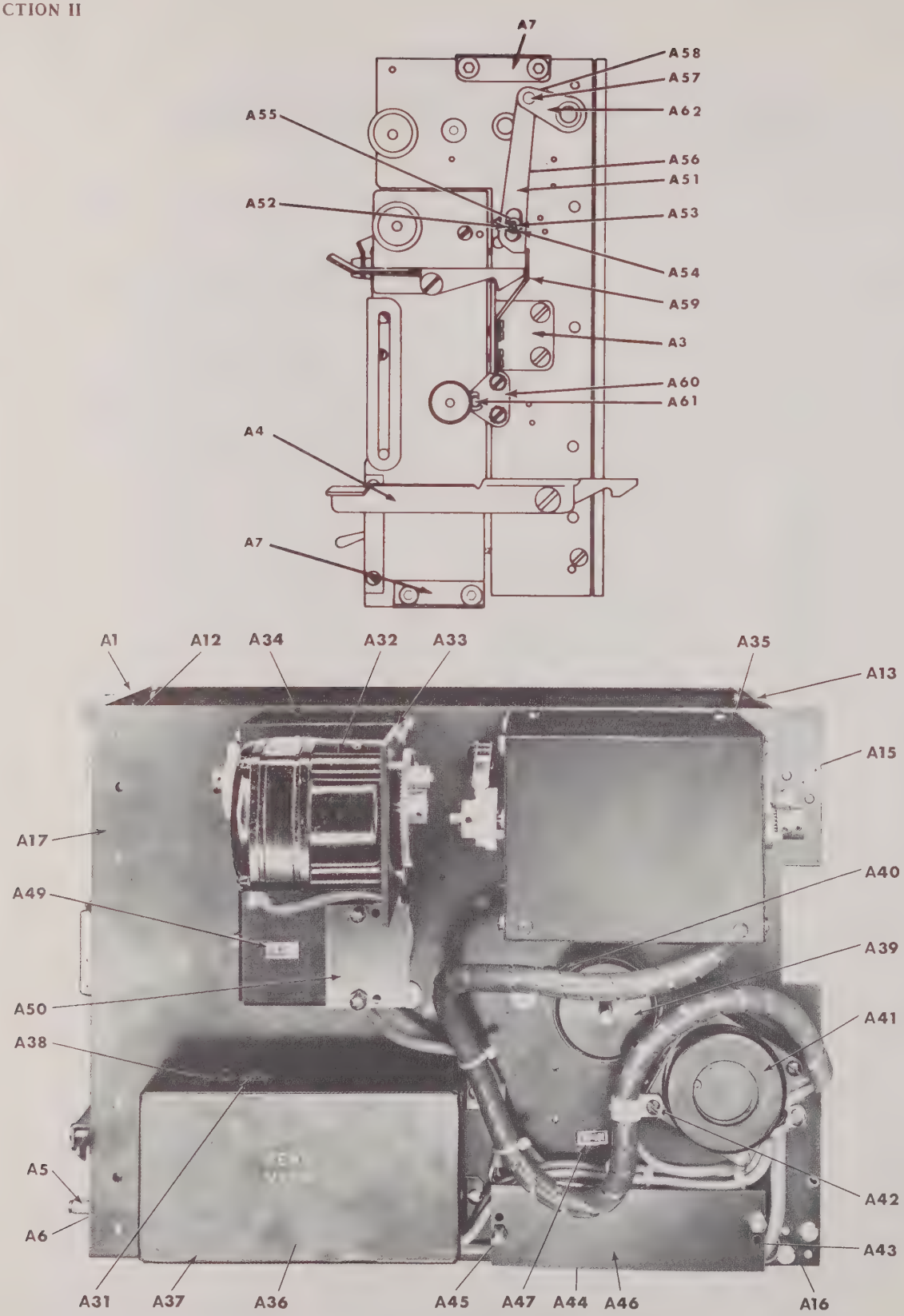
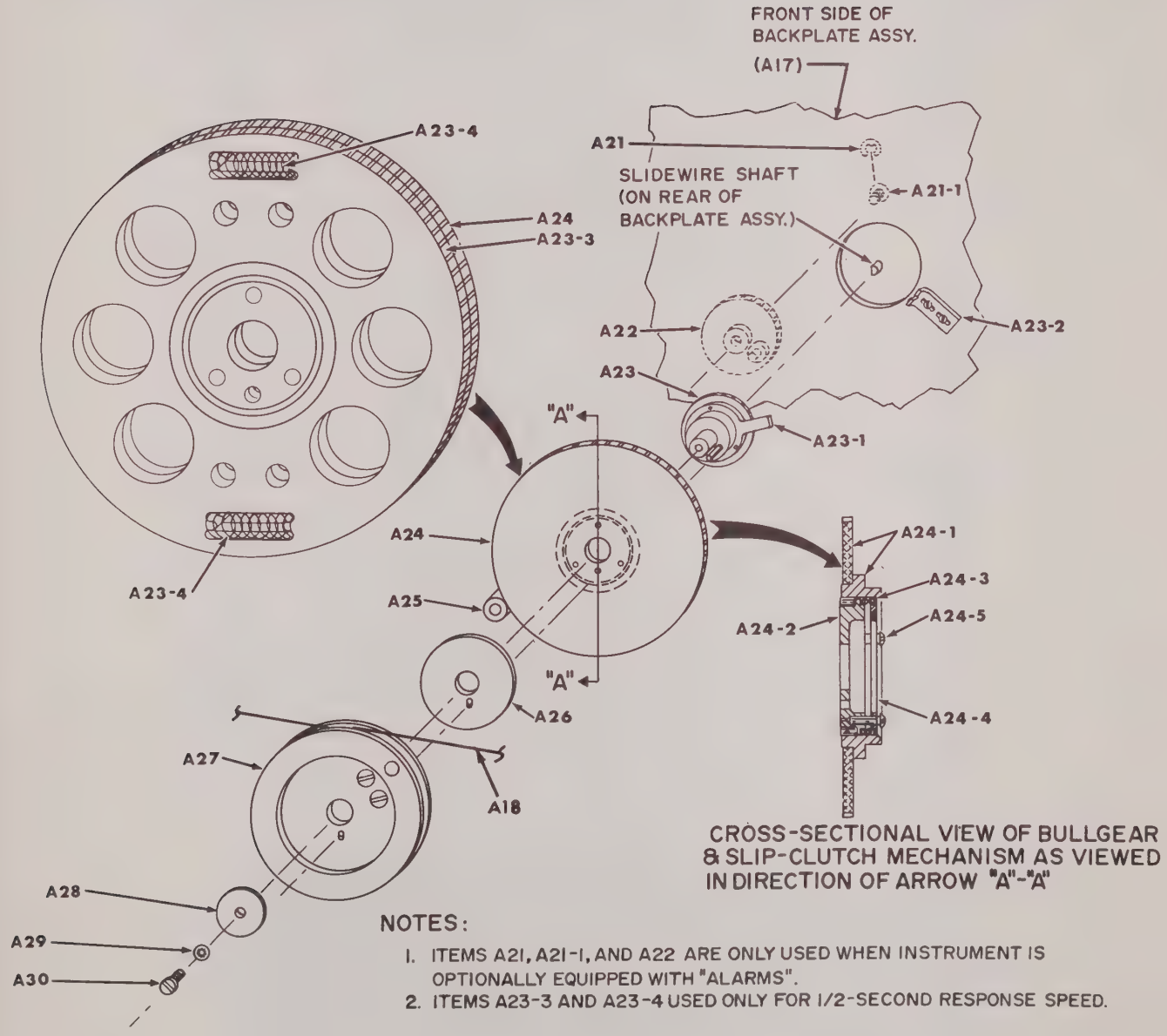


FIGURE 4.8. MAIN FRAME MECHANISM PARTS.



NOTES:

1. ITEMS A21, A21-1, AND A22 ARE ONLY USED WHEN INSTRUMENT IS OPTIONALLY EQUIPPED WITH "ALARMS".
2. ITEMS A23-3 AND A23-4 USED ONLY FOR 1/2-SECOND RESPONSE SPEED.

FIGURE 4.8. MAIN FRAME MECHANISM PARTS.

MAIN FRAME (CONT'D)

FIG. 4.8 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
A26	54078	Spacer, Pulley	1
A27	54121	Pulley, Cable Drive	1
A28	54122	Retainer, Pulley	1
A29	ND40221-1	Lockwasher	1
A30	NX91006	Screw	1
A31	54089	Decal, Cover ("Comp")	1
A32	*	Motor, Print (B302); Optional	1
	51497-20	20RPM (Supplied as Standard for Basic Print Rates of 1, 1.5, 3, 3.75, 6, and 7.5 Sec. Print Freq.)	
	51497-4	4RPM (Supplied as Standard for Basic Print Rates of 15, 30, and 37.5 Sec. Print Freq.)	
A33	*	Gearbox Assembly (Optional)	1
	51036	Includes #51497-4 Print Motor (A32); Less External Gears	
	51036-1	Less Print Motor (A32) and External Gears	
	51036-2	Includes #51497-20 Print Motor (A32); Less External Gears	
A34	51174	Cover, Gearbox Top	1
A35	*	Switch Assembly, Selector (S300); Optional	1
	50911	Standard Break-Before-Make Type (BBM)	
	50909	Special Make-Before-Break Type (MBB)	
A36	*	Reference (Zener) Voltage Supply Assembly; Optional	1
	54570-B-3	Supply Assembly Without TC Burnout	
	54570-B-4	Supply Assembly With Upscale TC Burnout	
	54570-B-5	Supply Assembly With Downscale TC Burnout	
A37	54059	Cover, Reference Voltage Supply	1
A38	54056	Decal, Cover ("Span")	1
A39	54048	Potentiometer, Feedback (Slidewire, R300); Combined with Shunt Resistor (R_{SW}) to Total an Equivalent Resistance of 900Ω, ±0.1%.	1
A40	404613-1	Mounting Dog, Potentiometer	3
A41	*	Motor, Servo Balance, B301 (Optional)	1
	54040-1 or 51114	Without Integral Gearbox (1200 RPM, 1/2 Second Response)	
	54041-1 or 51671	With Integral Gearbox (120RPM, 1- and 4-Second Response)	
	54041-1 or 51671	With Integral Gearbox (7RPM; 15-, 20-, and 30-Second Response)	
A42	400379-5	Spacer, Cable Mounting	1
A43	41040-12	Terminal Block, 12-Position (TB-401)	1
A44	41041-16	Marker Strip, Terminal Block	1
A45	50607	Spacer Nut, Terminal Cover	2
A46	50802-1	Cover, Terminal Block	1
A47	54223-401	Decal, Terminal Block Decal (TB-401)	1
A49	54223-303	Decal, Terminal Block (TB-303)	1
A50	ND40080-7	Cover, Terminal Block	1
A51	50812	Arm Latch, Pivot Shaft Actuating	1
A52	21398	Ring, "E" Retaining	1
A53	50810	Post	1
A54	21675	Washer	2
A55	50813	Roller	1
A56	50811	Spring, Extension	1
A57	50809	Pin	1
A58	50814	Spacer	2
A59	50806	Spring, Arm Latch Retaining	1
A60	50808	Plate, Chart Drive Support	2
A61	51267	Pin, Support Plate	1
A62	51334	Arm and Hub Assembly	1

* Refer to Instrument Data Sheet.

MAIN FRAME (CONT.)

FIG. 4.9 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
B1	51335	Cam Follower Assembly	1
B2	50804	Pivot Shaft, Print Mechanism	1
B4	51302	Spacer, Pivot Shaft	1
B5	51334	Arm and Hub Assembly	3
B6	51229	Pawl, Switch Advance	1
B7	51267	Pin, Pawl Mounting	1
B8	51421	Idler Gear, Pinion Rod	1
B9	51157-1	Pinion Rod, Point Advance (.473" O.D.)	1
B10	51125	Idler Gear Assembly, Point Advance	1
B11	51345	Pinion Assembly, Point Advance	1
B12	**	Indicator Wheel, Point (Optional)	1
	51210-2	2-Point Wheel	
	51210-3	3-Point Wheel	
	51210-4	4-Point Wheel	
	51210-6	6-Point Wheel	
	51210-8	8-Point Wheel	
	51210-10	10-Point Wheel	
	51210-12	12-Point Wheel	
	51210-16	16-Point Wheel	
	51210-18	18-Point Wheel	
	51210-20	20-Point Wheel	
	51210-24	24-Point Wheel	
B13	12084	Knob, Manual Point Advance	1
B14	51295	Shaft, Printhead Actuating	1
B15	51002	Printhead Assembly	1
B16	51111	Support Bar, Printhead (On Chart Transport)	1
	51298	Plate, Scale Mounting	1
	**	Scaleplate (Optional)	1
	54229	Decal, Terminal Code Plate (Specify Typing)	1
B17	50849	Adjustable Pulley and Bracket Assembly (On Right Sideplate)	1
B18	50848	Pulley and Bracket Assembly (On Left Sideplate)	1

** Refer to Instrument Data Sheet.

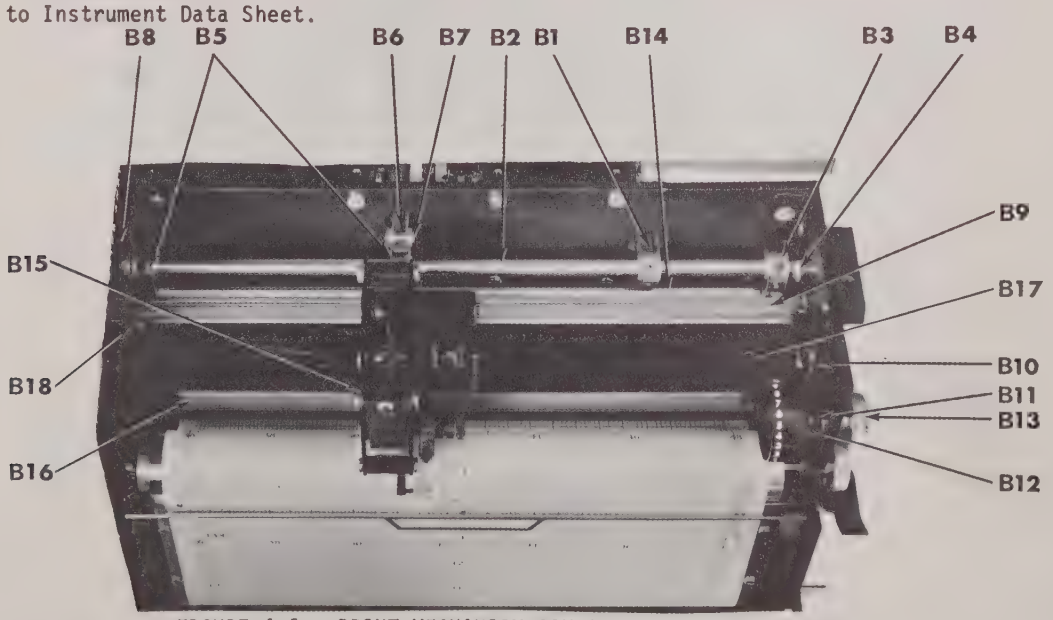


FIGURE 4.9. PRINT MECHANISM COMPONENTS ON MAIN FRAME.

SELECTOR SWITCH ASSEMBLY

REPLACEMENT PARTS LIST

FIG. 4.10 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	50909	Selector Switch Assembly (Shorting)	1
	50911	Selector Switch Assembly (Non-Shorting)	
C1	50906	Deck and Cable Assembly (MBB)	1
	50907	Deck and Cable Assembly (BBM)	
C2	63207-2	Rotor Assembly, Switch (MBB)	1
	51126-2	Rotor Assembly, Switch (BBM)	
C3	51362	Collar, Shaft	2
C4	51251	Shaft, Switch	1
C5	ND40178-2	Bearing, Thrust Ball	1
C6	24314-1	Washer, Thrust Bearing	4
C7	50959	Plate Assembly, R.H. (Ratchet End)	1
C8	50959	Plate Assembly, L.H. (Deck End)	1
C9	50935	Spacer Post, Switch	4
C11	51201	Stud, Deck Mounting (Threaded)	3
C12	51469	Nut, Switch Mounting	6
C14	51422	Ratchet Assembly, Nylon	1
C15	51361	Plate Assembly, Mounting	1
C16	51143	Pinion Assembly, Output	1
C17	51362	Collar, Output Shaft	1
C18	51421	Gear Assembly, Output	1
*	50939	Cover, Top Switch	1

*Not Illustrated

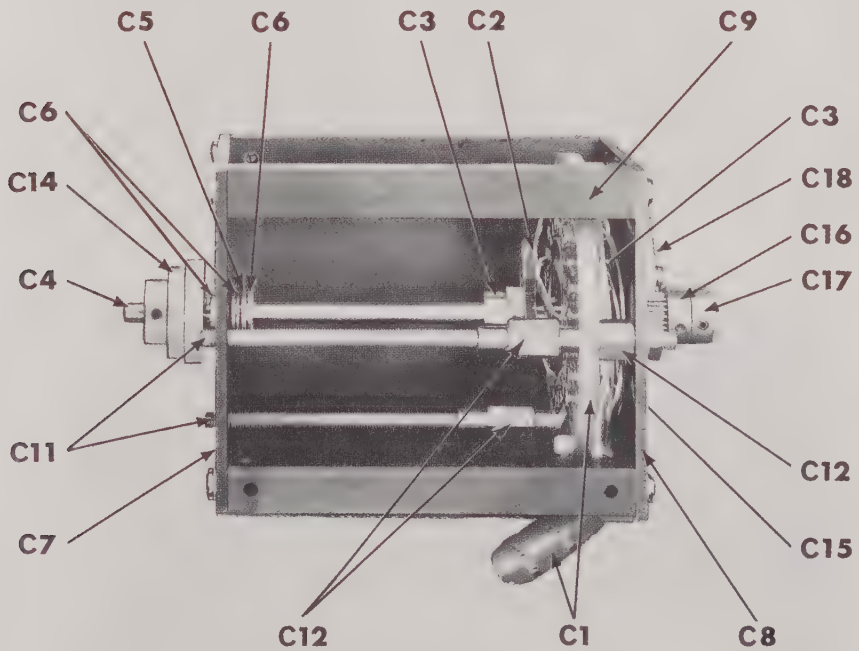


FIGURE 4.10. SINGLE-DECK SELECTOR SWITCH

GEARBOX ASSEMBLY REPLACEMENT PARTS LIST

FIG. 4.11 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	*	GEARBOX ASSEMBLY (OPTIONAL)	1
	51036	INCLUDES #51497-4 PRINT MOTOR (A32); LESS EXTERNAL DRIVE GEARS (D14, D15)	
	51036-1	LESS PRINT MOTOR (A32) AND EXTERNAL DRIVE GEARS (D14, D15)	
	51036-2	INCLUDES #51497-20 PRINT MOTOR (A32); LESS EXTERNAL DRIVE GEARS (D14, D15)	
A32	*	PRINT MOTOR (B302); OPTIONAL	1
	51497-20	20RPM (SUPPLIED AS STANDARD FOR 1.5 THRU 30 SEC. PT. FREQ.)	
	51497-4	4RPM (SUPPLIED AS STANDARD FOR 60 THRU 150 SEC. PT. FREQ.)	
D2	51485	LEFT-HAND PLATE ASSEMBLY	1
D3	51354	RIGHT-HAND PLATE ASSEMBLY	1
D4	51443	SHAFT, CAM	1
D5	51451	HUB	1
D6	51162	OUTPUT CAM ASSEMBLY	1
D7	51239	CAM, SIGNAL CUTOFF SWITCH ACTUATING	1
D8	51382	CAM, SELECTIVE ALARM SWITCH ACTUATING (SELECTIVE ALARM OPTION	1
D9	51473	GEAR AND INTERMEDIATE SHAFT ASSEMBLY	1
D10		SIGNAL CUTOFF SWITCH (S302) ASSEMBLY; CONSISTS OF:	1
	243211	ACTUATOR, SWITCH	1
	243212	CONTACT, ACTUATED (SILVER)	1
	243213	CONTACT, FIXED (PALLADIUM)	1
	243214	INSULATOR, CONTACT	2
	ND40104-1	SCREW, MOUNTING (NYLON)	2
D11	51306	BRACKET, SWITCH MOUNTING	1
D12	51287	POST, SPACER	1
D13	51325	POST, SPACER	3
D14	*	DRIVING GEAR (OPTIONAL):	1
	†50860	1 AND 4 SEC. PRINT FREQ. (72 TEETH, ALUMINUM)	
	†51379	1.5 AND 6 SEC. PRINT FREQ. (60 TEETH, ALUMINUM)	
	†51378	3 AND 12 SEC. PRINT FREQ. (40 TEETH, BLACK)	
	†51479	3.75 AND 15 SEC. PRINT FREQ. (34 TEETH, BLUE)	
	†51375	6 AND 24 SEC. PRINT FREQ. (20 TEETH, COPPER)	
	‡51381	6 AND 24 SEC. PRINT FREQ. (55 TEETH, BLUE)	
	†51489	7.5 AND 30 SEC. PRINT FREQ. (20 TEETH, PLAIN)	
	‡51379	7.5 AND 30 SEC. PRINT FREQ. (60 TEETH, ALUMINUM)	
	π51378	15 AND 60 SEC. PRINT FREQ. (40 TEETH, BLACK)	
	π51375	30 AND 120 SEC. PRINT FREQ. (20 TEETH, COPPER)	
	π51489	37.5 AND 150 SEC. PRINT FREQ. (20 TEETH, PLAIN)	
D15	*	DRIVEN GEAR (OPTIONAL):	1
	†51379	1 AND 4 SEC. PRINT FREQ. (48 TEETH, ALUMINUM)	
	†51379	1.5 AND 6 SEC. PRINT FREQ. (60 TEETH, ALUMINUM)	
	†51377	3 AND 12 SEC. PRINT FREQ. (80 TEETH, BLACK)	
	†51480	3.75 AND 15 SEC. PRINT FREQ. (85 TEETH, BLUE)	
	†51376	6 AND 24 SEC. PRINT FREQ. (80 TEETH, COPPER)	
	θ51380	6 AND 24 SEC. PRINT FREQ. (44 TEETH, BLUE)	
	†51478	7.5 AND 30 SEC. PRINT FREQ. (100 TEETH, BLACK)	
	θ51379	7.5 AND 30 SEC. PRINT FREQ. (60 TEETH, ALUMINUM)	
	π51377	15 AND 60 SEC. PRINT FREQ. (80 TEETH, BLACK)	
	π51376	30 AND 120 SEC. PRINT FREQ. (80 TEETH, COPPER)	
	π51478	37.5 AND 150 SEC. PRINT FREQ. (100 TEETH, BLACK)	
D16	51442	GEAR, PINION, AND HUB ASSEMBLY	1
D17	51259	HOUSING, MOTOR CONTROL	1
D18	51166	SWITCH (S303), PRINT MOTOR	1
D19	51494	CAPACITOR (C302); 1.0MFD @ 220V AC	1
D20	52578-3	TERMINAL BLOCK (TB303)	1

*REFER TO INSTRUMENT DATA SHEET.
†SUPPLIED AS STANDARD WHEN UTILIZING #51497-20 PRINT MOTOR (A32).
‡ALTERNATE DRIVING GEAR SUPPLIED WHEN UTILIZING #51497-4 PRINT MOTOR (A32).
θALTERNATE DRIVEN GEAR SUPPLIED WHEN UTILIZING #51497-4 PRINT MOTOR (A32).
πSUPPLIED AS STANDARD WHEN UTILIZING #51497-4 PRINT MOTOR (A32).

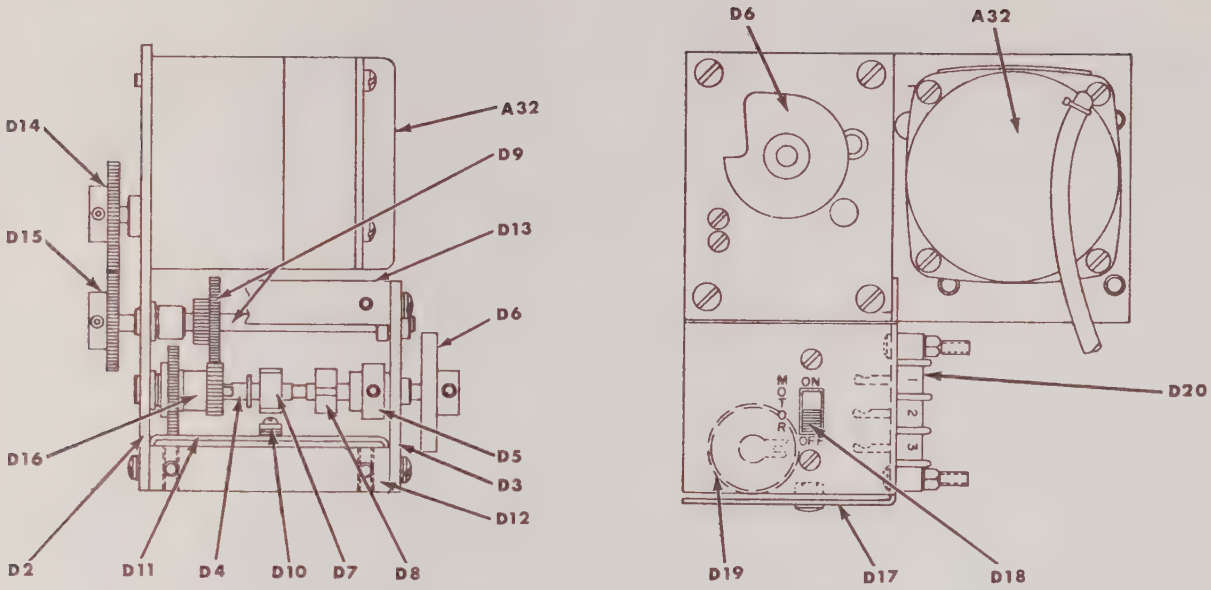


FIGURE 4.11. PARTS IDENTIFICATION OF GEARBOX ASSEMBLY.

INK WHEEL ASSEMBLY REPLACEMENT PARTS LIST

FIG. 4.12 INDEX NO.	PART NUMBER	DESCRIPTION	QUANTITY
G1	*	Ink Wheel Assy., Unicolor (Optional)	1
	51027-1	Red	
	51027-2	Green	
	51027-3	Blue	
	51027-4	Black	
	51027-5	Purple	
	51027-6	Brown	
G2	50882	Ink Wheel, Unicolor (Less Pad and Washer)	1
G3	50879	Washer, Pad Retaining	1
G4	ND40220-2	Lockwasher	1
G5	51307	Nut, Wheel Retaining (Knurled)	1
	51029-**	Replacement Ink Pads (Two Per Tin)	As Req'd
H1	*	Ink Wheel Assy., Multicolor (Optional)	1
	51026-2	Two Color (Red-Green)	
	51026-3	Three Color (Red-Green-Blue)	
	51026-4	Four Color (Red-Green-Blue-Black)	
	51026-6	Six Color (Red-Green-Blue-Black-Purple-Brown)	
H2	50885	Ink Wheel, Multicolor (Less Pads and Washer)	1
H3	50881	Washer, Pad Retaining	1
	DS-03	Drive-Screw, Washer	2
H4	50888	Disc Assembly (Keying Kit)	1
H5	50884	Disc, Wheel (Notch Keyed)	1
H6	50883	Disc, Shaft (Tab Keyed)	1
H7	ND40214-17	Screw, Disc Adjustment	2
H8	ND40220-2	Lockwasher	1
H9	51307	Nut, Wheel Retaining (Knurled)	1

* See Data Sheet. ** Specify color.

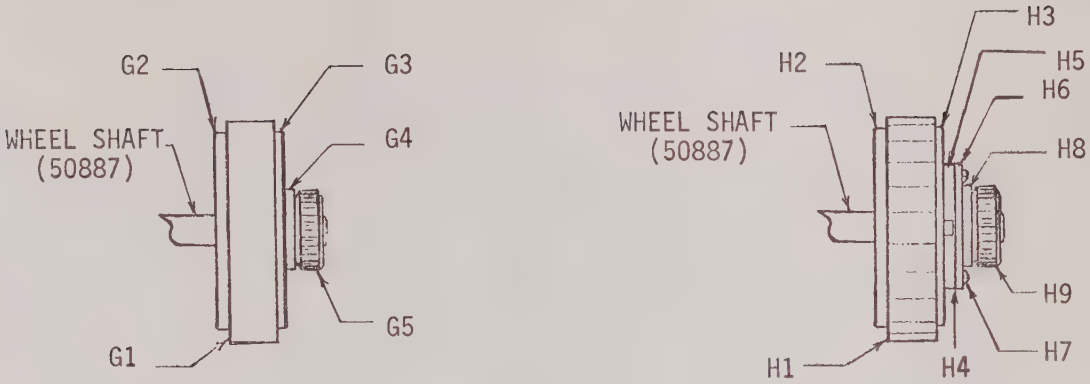


FIGURE 4.12. INK WHEEL COMPONENT LOCATION.

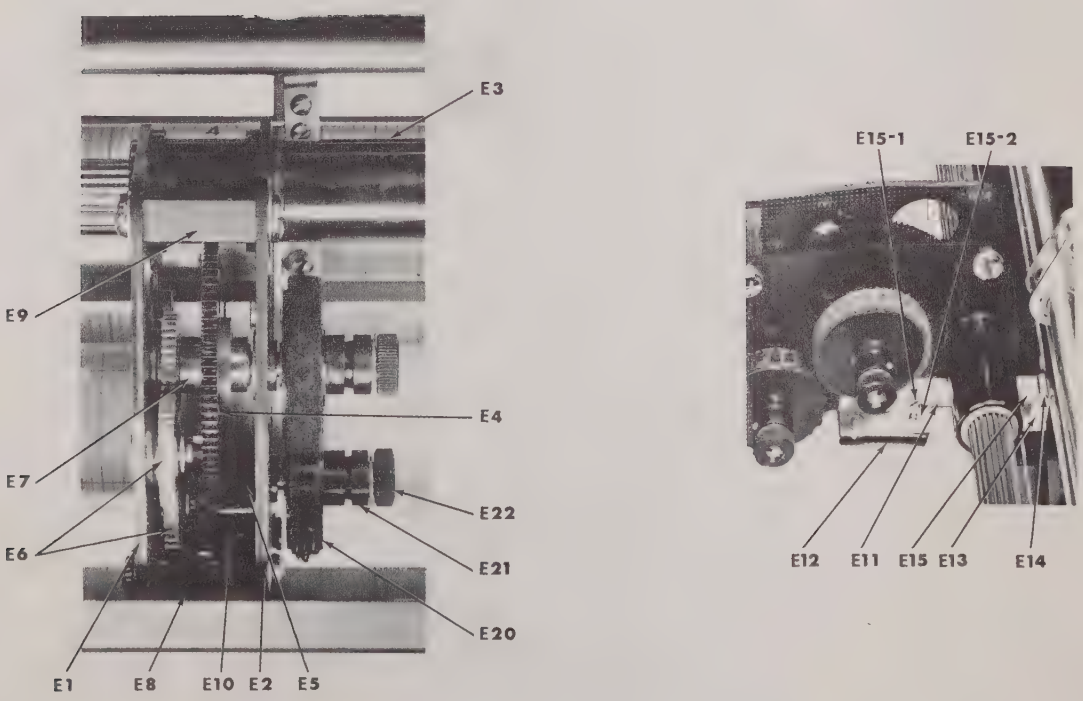


FIGURE 4.13. PARTS EMPLOYED IN PRINTHEAD ASSEMBLY.

PRINTHEAD ASSEMBLY

REPLACEMENT PARTS LIST

FIG. 4.13 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	51002	PRINTHEAD ASSEMBLY (FOR PINION ROD 51157-1)	1
E1	51331	PLATE ASSEMBLY, L.H.	1
E2	51332	PLATE ASSEMBLY, R.H.	1
E3	50850	BEARING ASSEMBLY (PRINTHEAD 51002 ONLY)	1
E4	51316	IDLER GEAR (99T)	1
E5	51315	SHAFT ASSEMBLY, PRINT WHEEL	1
E6	51329	IDLER GEAR, INKING WHEEL	2
E7	50887	SHAFT ASSEMBLY, INKING WHEEL	1
E8	51320	SPACER POST, ASSEMBLY (UPPER FRONT)	1
	51321	SPACER POST, ASSEMBLY (LOWER FRONT)	1
E9	51322	SPACER POST, ASSEMBLY (REAR)	2
E10	51273	SPRING, FRONT DETENT	1
E11	51231	BRACKET, ROLLER AND SPRING	1
E12	51350	SPRING, IMPACT (BRONZE)	1
E13	51323	ROLLER, PRINTHEAD LIFT	1
E14	51315	SHAFT, ROLLER	1
E15	51314	CLAMP, SERVO CABLE	1
E15-1	NX-50206	ADJUSTMENT SCREW, #2-56 X 3/8" LONG	1
E15-2	NX-2002	ADJUSTMENT LOCKNUT, 3/16"	1
E20	***	PRINT WHEEL ASSEMBLY (OPTIONAL)	1
	51019-2	2-POINTS (STATIONS)	
	51019-3	3-POINTS (STATIONS)	
	51019-4	4-POINTS (STATIONS)	
	51019-6	6-POINTS (STATIONS)	
	51019-8	8-POINTS (STATIONS)	
	51019-10	10-POINTS (STATIONS)	
	51019-12	12-POINTS (STATIONS)	
	51019-16	16-POINTS (STATIONS)	
	51019-18	18-POINTS (STATIONS)	
	51019-20	20-POINTS (STATIONS)	
	51019-24	24-POINTS (STATIONS)	
E21	51311	SLEEVE, WHEEL RETAINING	1
E22	51307	NUT, WHEEL RETAINING (KNURLED)	1
	51312	POINTER, SCALE INDICATING	1

***REFER TO INSTRUMENT DATA SHEET.

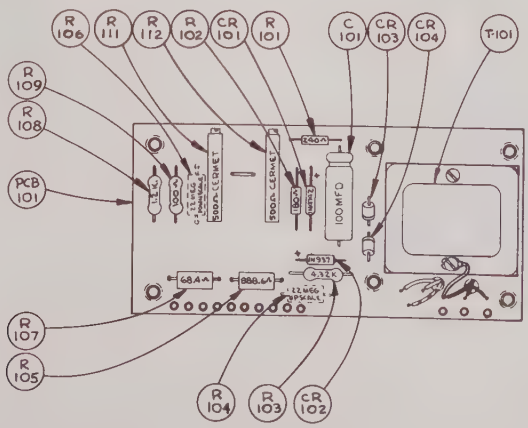


FIGURE 4.14. PARTS IDENTIFICATION ON REFERENCE VOLTAGE SUPPLY PRINTED CIRCUIT BOARD.

REFERENCE VOLTAGE SUPPLY
REPLACEMENT PARTS LIST

FIG. 4.14 INDEX NO.	PART NUMBER	DESCRIPTION
		ASSEMBLIES
	*	Reference (Zener) Voltage Supply Assembly:
	54570-B-3	Supply Assembly Without TC Burnout Detection Circuitry
	54570-B-4	Supply Assembly Providing Upscale (R104) TC Burnout Detection Circuitry
	54570-B-5	Supply Assembly Providing Downscale (R106) TC Burnout Detection Circuitry
		Reference Voltage Supply PC Board Assembly:
	54571-B	Board Assembly Without TC Burnout Detection Circuitry
	54571-B-1	Board Assembly Providing Upscale (R104) TC Burnout Detection Circuitry
	54571-B-2	Board Assembly Providing Downscale (R106) TC Burnout Detection Circuitry
		CONTROLS AND RESISTORS
R101	RCC-1-241	240Ω, 5%, 1/2W
R102	RCC-2-181	180Ω, 10%, 1/2W
R103	43629-4	4320Ω, 1%, 1/2W
R104	RCC-2-226	22 meg., 10%, 1/2W (Provides Upscale Indication of TC Burnout)
R105	40724-54	888.6Ω, 0.1%, 1/3W
R106	RCC-2-226	22 meg., 10%, 1/2W (Provides Downscale Indication of TC Burnout)
R107	40724-55	68.4Ω, 0.1%, 1/3W
R108	43629-6	1200Ω, 1%, 1/2W
R109	43629-3	100Ω, 1%, 1/2W
R111	52225-1	500Ω, Span Control
R112	52225-1	500Ω, Comp. Control
		DIODES
CR101	52147-1	1N4742 (12V), Zener
CR102	54456	1N937 (9V), Zener
CR103	43421	1N4004, Rectifier
CR104	43421	1N4004, Rectifier
		CAPACITORS
C101	14440-100	100MFD. @ 25V, Electrolytic
		MISCELLANEOUS
T101	40811	Transformer, Power
PCB-101	54572-1	Printed Circuit Board (Less Components)

* Refer to Instrument Data Sheet

AMPLIFIER CHASSIS ASSEMBLY
REPLACEMENT PARTS LIST

FIG. 4.15 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	54550-*	AMPLIFIER CHASSIS ASSEMBLY (COMPLETE); 50/60Hz	1
M1	54568	BASEPLATE ASSEMBLY	1
M2	54598	PLATE, SUPPORT (FRONT PANEL)	1
M3	54414	MOUNTING BRACKET, CONNECTOR (PLUG)	1
M4	54560	COVER, AMPLIFIER CHASSIS	1
M5	54579	BUSHING, HEADED	4
M6	54558	INSULATOR, STANDOFF	4
M7	3240	WASHER, INSULATOR	4
M8	54535	PLATE, SHIELD	2
M9	54551-*	AMPLIFIER PC BOARD ASSEMBLY (50/60Hz)	1
P201	401259-0	CONNECTOR (PLUG)	1
TB201	54419	BLOCK, TERMINAL	1
M10	41039	JUMPER, ELECTRICAL TERMINAL	1
T203	54459	TRANSFORMER, POWER	1
C247	40756-3	CAPACITOR, ELECTROLYTIC; 200MFD. @ 12V	1

*REFER TO INSTRUMENT DATA SHEET

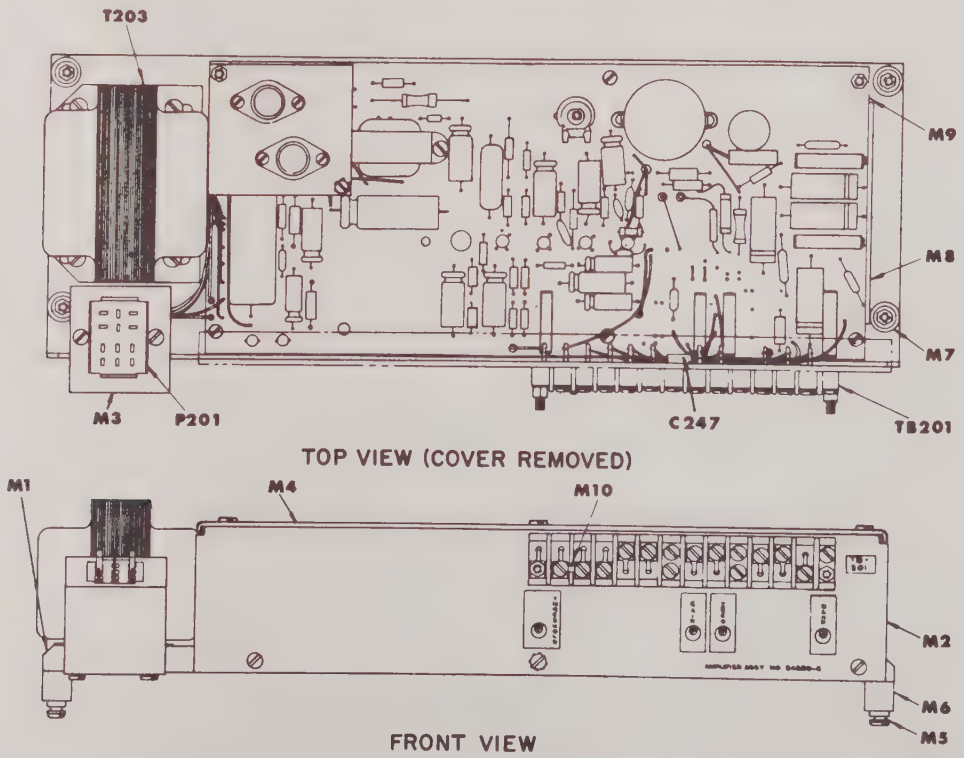


FIGURE 4.15. PARTS IDENTIFICATION ON AMPLIFIER CHASSIS ASSEMBLY.

AMPLIFIER PRINTED CIRCUIT BOARD REPLACEMENT PARTS LIST

FIG. 4.16 INDEX NO.	PART NUMBER	DESCRIPTION
		ASSEMBLIES
	54551-*	AMPLIFIER PC BOARD ASSEMBLY (50/60Hz APPLICATIONS)
		TRANSISTORS
Q201	44901	2N5210 (NPN), PREAMPLIFIER
Q202	44901	2N5210 (NPN), EMITTER FOLLOWER
Q203	52150	2N3565 (NPN), AMPLIFIER
Q204	52150	2N3565 (NPN), AMPLIFIER
Q205	54476	2N3566 (NPN), DRIVER
Q206	43128	40250 (NPN), OUTPUT
Q207	43128	40250 (NPN) OUTPUT
Q208	54476	2N3566 (NPN), VOLTAGE REGULATOR
		CONTROLS AND RESISTORS
R201	40724-13	1 MEG., 0.1%, 1/3W.
R202	40724-56	353.4Ω, 0.1%, 1/3W.
R205	52225-8	10KΩ, FILTER ADJUST CONTROL
R206	52123-1	2210Ω, 1.0%, 1/2W.
R207	52225-7	20KΩ, DAMPING CONTROL
R208	43629-9	5620Ω, 1.0%, 1/2W.
R209	43629-8	4990Ω, 1.0%, 1/2W.
R210	52225-6	2KΩ, FILTER ADJUST CONTROL
R211	43629-7	6190Ω, 1.0%, 1/2W.
R215	RCC-2-474	470KΩ, 10%, 1/2W.
R218	RCC-2-123	12KΩ, 10%, 1/2W.
R220	RCC-2-822	8.2KΩ, 10%, 1/2W.
R221	RCC-1-131	130Ω, 5%, 1/2W.
R222	RCC-2-332	3300Ω, 10%, 1/2W.
R223	RCC-2-332	3300Ω, 10%, 1/2W.
R224	RCC-2-104	100KΩ, 10%, 1/2W.
R226	RCC-2-332	3300Ω, 10%, 1/2W.
R227	RCC-2-101	100Ω, 10%, 1/2W.
R228	RCC-2-152	1500Ω, 10%, 1/2W.
R229	RCC-5-471	470Ω, 10%, 1W.
R230	RCC-5-471	470Ω, 10%, 1W.
R231	RCC-4-751	750Ω, 5%, 1W.
R232	RCC-4-621	620Ω, 5%, 1W.
R235	52225-3	200Ω, ZERO CONTROL (SCREWDRIVER ADJUST)
	54464-1	200Ω, ZERO CONTROL (KNOB ADJUST)
R236	52225-4	100KΩ, THRESHOLD CONTROL
R237	52225-2	50KΩ, GAIN CONTROL (SCREWDRIVER ADJUST)
	54464-2	50KΩ, GAIN CONTROL (KNOB ADJUST)
R238	RCC-2-150	15Ω, 10%, 1/2W.
R244	RCC-2-154	150KΩ, 10%, 1/2W.
R245	52123-6	221KΩ, 1.0%, 1/2W.
R246	54556-1	50KΩ, BIAS LEVEL CONTROL
R247	RCC-2-101	100Ω, 10%, 1/2W.
R249	RCC-2-103	10KΩ, 10%, 1/2W.

*REFER TO INSTRUMENT DATA SHEET.

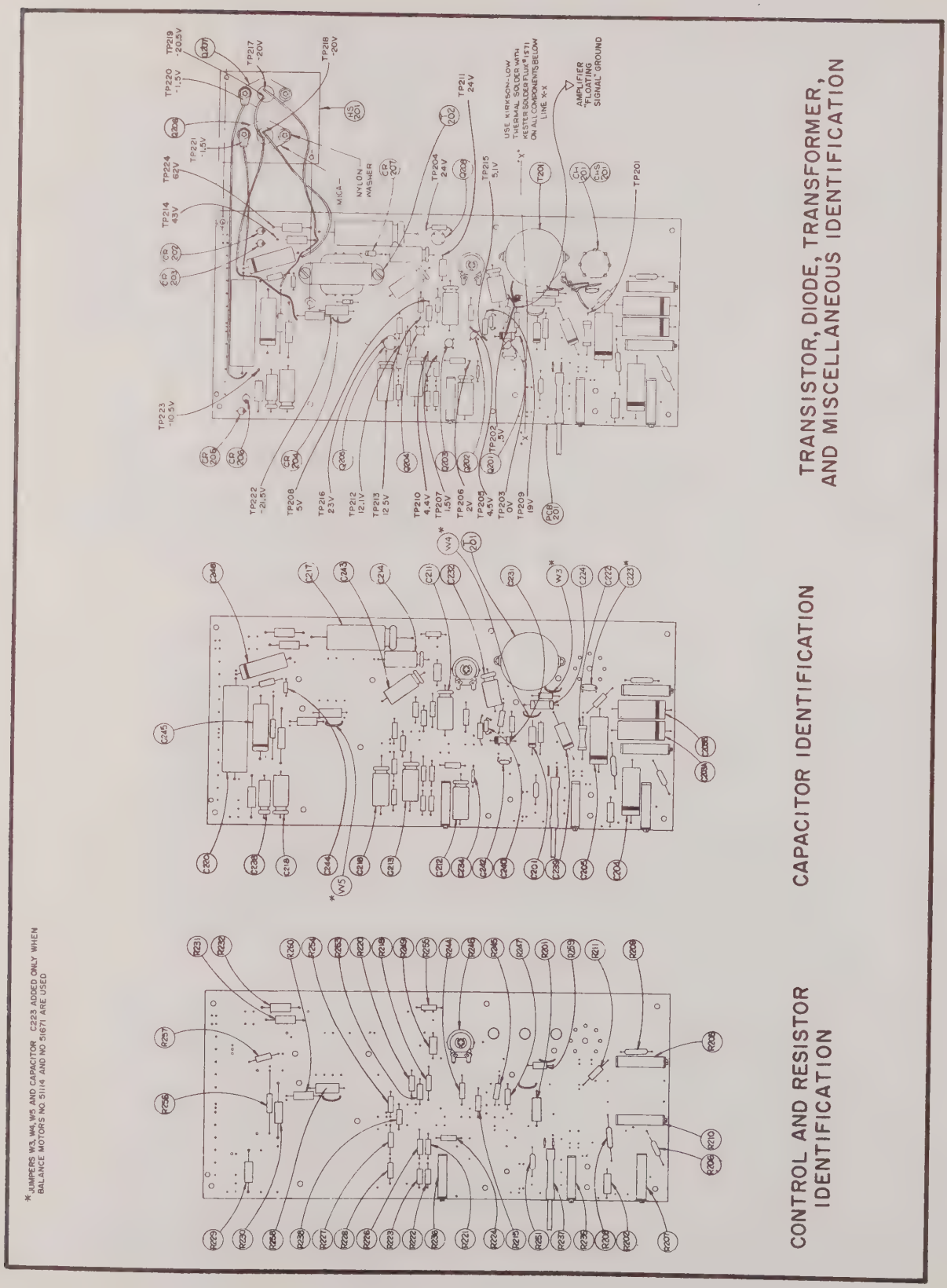

* JUMPERS W3, W4, W5 AND CAPACITOR C223 ADDED ONLY WHEN BALANCE MOTORS NO. 5111A AND NO. 5167I ARE USED
CONTROL AND RESISTOR IDENTIFICATION
CAPACITOR IDENTIFICATION
TRANSISTOR, DIODE, TRANSFORMER, AND MISCELLANEOUS IDENTIFICATION

FIGURE 4.16. PARTS IDENTIFICATION ON AMPLIFIER PRINTED CIRCUIT BOARD.

AMPLIFIER PRINTED CIRCUIT BOARD (CONT'D)

FIG. 4.16 INDEX NO.	PART NUMBER	DESCRIPTION
		CONTROLS AND RESISTORS (CONT'D)
R251	52123-2	10KΩ, 1.0%, 1/2W.
R253	RCC-2-153	15KΩ 10%, 1/2W.
R254	RCC-2-153	15KΩ, 10%, 1/2W.
R255	RCC-2-473	47KΩ, 10%, 1/2W.
R256	RCC-2-153	15KΩ, 10%, 1/2W.
R257	RCC-2-153	15KΩ, 10%, 1/2W.
R258	40784-5	5Ω, 3W.
R259	RCC-2-104	100KΩ, 10%, 1/2W.
R260	RCC-4-200	20Ω, 5%, 1W.
		CAPACITORS
C201	40736-14	.018MFD. @ 200V, 10%
C203A	CMM-10	.47MFD. @ 100V, 10%
C203B	CMM-10	.47MFD. @ 100V, 10%
C204	CMM-10	.47MFD. @ 100V, 10%
C205	CMM-10	.47MFD. @ 100V, 10%
C211	14440-100	100MFD. @ 25V, ELECTROLYTIC
C212	52095-8	300 MFD. @ 3V, ELECTROLYTIC
C213	52095-7	200MFD. @ 15V, ELECTROLYTIC
C214	14440-100	100MFD. @ 25V, ELECTROLYTIC
C216	52095-7	200MFD. @ 15V, ELECTROLYTIC
C217	54453	100MFD. @ 50V, ELECTROLYTIC
C218	14440-100	100MFD. @ 25V, ELECTROLYTIC
C220	54515	1.0MFD. @ 200V, ELECTROLYTIC
C222	40736-4	.047MFD. @ 200V, 10%
C223	CDC-21	.05MFD. @ 500V
C224	40736-2	.01MFD. @ 200V
C231	40736-4	.047MFD. @ 200V, 10%
C232	52095-5	100MFD. @ 6V, ELECTROLYTIC
C234	CDC-25	1.0MFD. @ 25V
C238	52095-6	10MFD. @ 50V, ELECTROLYTIC
C239	40736-13	.033MFD. @ 200V, 10%
C240	40736-1	500PF.
C242	CDC-29	.0022MFD. @ 100V
C243	14440-100	100MFD. @ 25V, ELECTROLYTIC
C244	CDC-25	1.0MFD. @ 25V
C245	CMM-32	.22MFD @ 200V, 10%
C246	CMM-32	.22MFD @ 200V, 10%
		DIODES
CR202	43421	1N4004, RECTIFIER
CR203	43421	1N4004, RECTIFIER
CR204	54455	1N659, TEMPERATURE COMPENSATING
CR205	43421	1N4004, RECTIFIER
CR206	43421	1N4004, RECTIFIER
CR207	52147-5	1N4749, ZENER
		TRANSFORMERS
T201	54458	CHOPPER (MICROTRAN 8053)
T202	54460	DRIVER (UTRAD T-16)
		MISCELLANEOUS
CH201	54465-1	CHOPPER (CAMBRIDGE 227A)
CHS201	54696	SOCKET, CHOPPER
HS201	54410	HEAT SINK, POWER TRANSISTORS
PCB201	54547	PC BOARD (LESS PARTS)

TERMINAL MOUNTING PLATE ASSEMBLY

REPLACEMENT PARTS LIST

FIG 4.17 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	54200	TERMINAL MOUNTING PLATE ASSEMBLY (WITHOUT #327 CHART DRIVE)	1
	54222	TERMINAL MOUNTING PLATE ASSEMBLY (WITH #327 CHART DRIVE)	1
C1	54205	MOUNTING PLATE	1
C2	54209	COVER, INSULATING	1
C3	54209	PLATE, INSULATING TERMINAL	1
	54212	CONNECTION PANEL ASSEMBLY	1
CP301	54211	CONNECTION PANEL	1
C4	43107-1	STUD, POWER WIRING TERMINAL CONNECTION	20
C5	43107-1	STUD, ACCESSORY EQUIPMENT TERMINAL CONNECTION	AS REQ'D.
C6	54219	MARKER, ACCESSORY EQUIPMENT TERMINAL IDENTIFICATION	AS REQ'D.
C7	54206	HANDLE	1
C8	8988-5	CLAMP, POWER CORD	1
C9	14358	FUSEHOLDER	1
C11	8935G	POWER CORD	1
F301	14359-2	FUSE, LINE (2A, 125V, SLO-BLO)	1
C301	13829	CAPACITOR, BALANCE MOTOR (1.2MFD. @ 600V)	1
C303, C304	40534	CAPACITOR, CHART DRIVE MOTOR; 1.5MFD. @ 600V DC (REQUIRED FOR #327 CHART DRIVE ONLY)	2
C305	51494	CAPACITOR, CHART DRIVE MOTOR; 1.0MFD. @ 220V AC (REQUIRED FOR #327 CHART DRIVE ONLY)	1
C306	CMM-46	CAPACITOR, FILTER; .47MFD. @ 600V DC	1

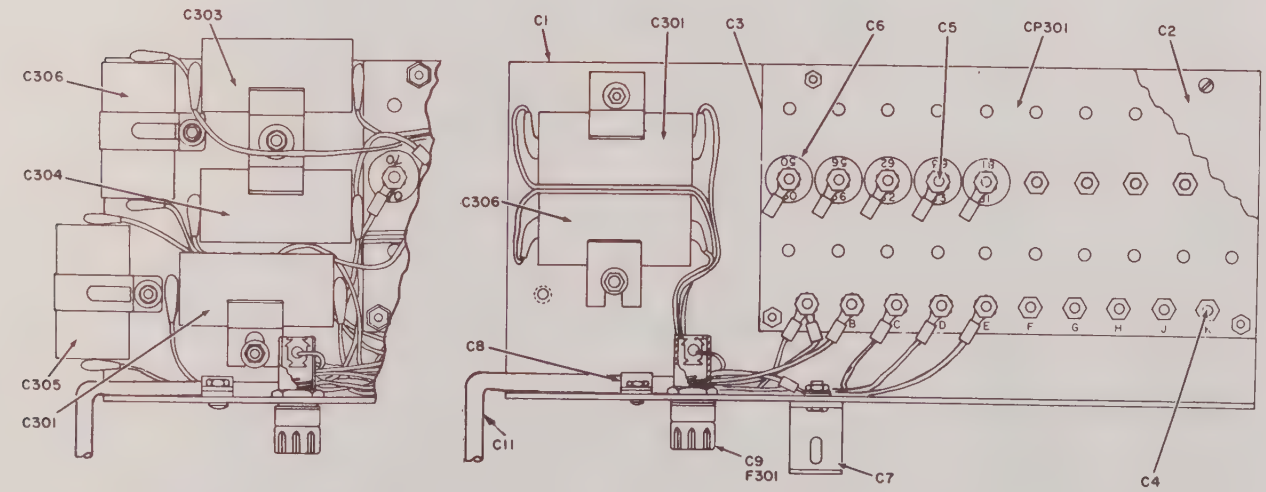


FIGURE 4.17. PARTS IDENTIFICATION ON TERMINAL MOUNTING PLATE ASSEMBLY.

SECTION III

MODEL E1124E

INSTRUMENT CASE ASSEMBLY

CASE ASSEMBLY AND CASE ATTACHING PARTS REPLACEMENT PARTS LIST

FIG. 4.18 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
		STANDARD EQUIPMENT ITEMS	
F1	51625-5*	Case Assembly (Single-Range Recorders)	1
	51625-6*	Case Assembly (Dual-Range and 48-point Recorders)	1
F2	241004	Bracket, Hanger Mounting (Bottom)	1
F3	ND40179-1*	Button, Plug (For 1-1/8" Dia. Knockout Hole)	2
	ND40179-2*	Button, Plug (For 1-1/4" Dia. Knockout Hole)	5
F4	51700-15	Gray Door Assembly With Double-Strength Glass Window	1
	51700-12	Charcoal Door Assembly With Double-Strength Glass Window	1
	51700-15-1	Gray Door Assembly With Plastic Window	1
	51700-12-1	Charcoal Door Assembly With Plastic Window	1
	51700-15-2	Gray Door Assembly With Laminated Safety Glass Window	1
	51700-12-2	Charcoal Door Assembly With Laminated Safety Glass Window	1
	51700-15-3	Gray Door Assembly With Non-Glare Glass Window	1
	51700-12-3	Charcoal Door Assembly With Non-Glare Glass Window	1
	51701-15	Door, Gray (Less Attaching Parts)	1
	51701-12	Door, Charcoal (Less Attaching Parts)	1
F5	19840-A	Nameplate (Gray)	1
	19840-B	Nameplate (Charcoal)	1
F6	51703	Pins, Upper and Lower Hinge	2
F7	51713-1	Cotter, Hair Pin	4
F9	51578	Window Door (Double-Strength Glass)	1
	51578-1	Window, Door (Plastic)	1
	51578-2	Window, Door (Laminated Safety Glass)	1
	51578-3	Window, Door (Non-Glare Glass)	1
F10	51704	Clip, Door Window Retaining	1
F11	51705	Clip, Door Window Retaining	1
F12	51706	Clip, Door Window Retaining	1
F13	51707	Clip, Door Window Retaining	1
F14	0660	Gasket, Glass	1
F15	19824	Gasket, Door	1
F16	51538	Latch Assembly, Door	1
F17	19830	Lock Assembly, Door (With Keys)	1
F18	51543	Bracket, Door Latching	1
F19	52232	Block, Hinge	2
F21	54589-4	Power Cable Harness and Socket (J201) Assembly	1
	54445	Socket (J201)	1
TB501	**	Signal Input Panel Assembly	1
F23	54587	Decal, Floating Amplifier Warning	1
F24	54490-**	Range Card or Cards (Under Range Card Shield)	As Req'd.

* Specify Color
** Refer to Instrument Data Sheet

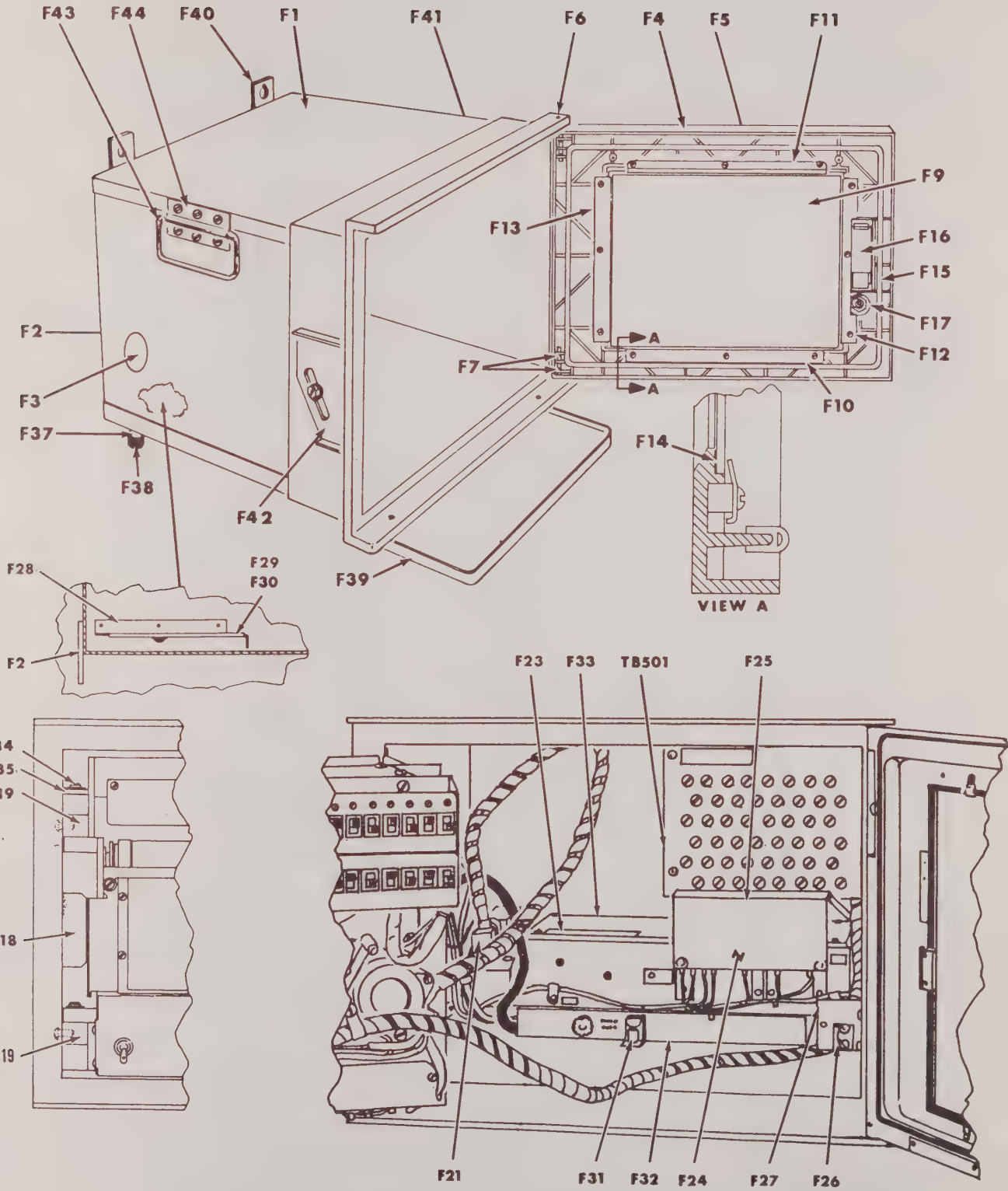
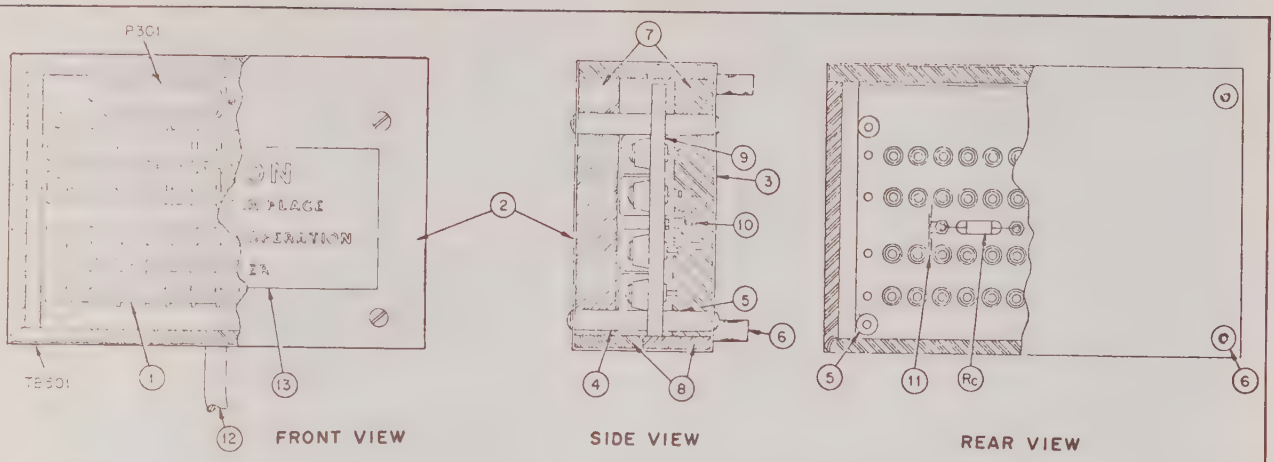


FIGURE 4.18. CASE ASSEMBLY AND ATTACHING PARTS.

CASE PARTS (CONT'D)

FIG. 4.18 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
F25	54584	Shield, Range Card	1
F26	52503	Bracket, Chart Drive Support	1
F27	52501	Bracket, Main Frame Latching	1
F28	54575	Bracket, Amplifier Mounting	2
F29	54578	Slide Latch, Right-Hand	1
F30	54577	Slide Latch, Left-Hand	1
F31	52583	Knob, Terminal Mounting Plate Retaining	1
F32	54200	Terminal Mounting Plate Assembly (Without #327 Chart Drive)	1
	54222	Terminal Mounting Plate Assembly (With #327 Chart Drive)	1
F33	54550-**	Chassis Assembly, Amplifier (Complete); 60Hz; 50Hz	1
F34	52097	Pin, Hinge	2
F35	51091	Stop, Main Frame Mechanism	1
		OPTIONAL EQUIPMENT ITEMS	
F37	51530	Foot (Rear Case)	2
F38	45024	Bumper, Foot (Rear Case)	2
F39	51528	Bar, Anti-Tip	1
F40	241005	Bracket, Hanger Mounting (Top)	2
F41	241002	Bracket, Left-Hand Panel Mounting	1
F42	241003	Bracket, Right-Hand Panel Mounting	1
F43	51531-2	Handle, Carrying	2
F44	51531-1	Clamp, Handle	2
NOT ILLUSTRATED	51094	Fluorescent Lamp, Shield, and Bracket Assembly	1
	51539	Lamp, Fluorescent (I601)	1
	51093	Shield, Fluorescent Lamp	1
	41061	Socket, Fluorescent Lamp	2
	51090	Clip, Lamp Socket	2
	51102-2	Bracket Assembly, Scale Mounting	1
	51095	Fluorescent Lighting Ballast Assembly	1
	19740	Starter, Fluorescent Lamp (M602)	1
	ND28931	Socket, Starter	1
	51095-1	Ballast (M601); 60Hz	1
	51095-2	Ballast (M601); 50Hz	1
	19744	Switch, Lamp (S601)	1
	54336	Cover	1
	51103	Incandescent Lamp and Bracket Assembly	1
	404563	Lamp (#44), Incandescent (I601, I602, I603, I604)	4
	51106	Shield, Incandescent Lamp	1
	52210	Lampholder	4
	51102-1	Bracket Assembly, Scale Mounting	1
	54343	Switch and Transformer Assembly, Incandescent Lighting	1
	204031	Transformer (T601)	1
	19744	Switch (S601)	1
	404665	Resistor (R601, .75Ω)	1
	54336	Cover	1

**-Refer to Instrument Data Sheet



UNIVERSAL INPUT PANEL PARTS LIST

INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
TB501	50890 ¶	SINGLE-RANGE INPUT PANEL ASSEMBLY	1 A/R*
TB501	50936 ¶	DUAL-RANGE INPUT PANEL ASSEMBLY	1 A/R*
TB501	50970 §	SINGLE- AND DUAL-RANGE INPUT PANEL ASSEMBLY	1 A/R*
P301 π	42051	.PLUG, NUMBER-OF-POINTS	1
J301**	401156-2	.SOCKET, 2-POINT	1 A/R*
	401156-3	.SOCKET, 3-POINT	1 A/R*
	401156-4	.SOCKET, 4-POINT	1 A/R*
	401156-6	.SOCKET, 6-POINT	1 A/R*
	401156-8	.SOCKET, 8-POINT	1 A/R*
	401156-10	.SOCKET, 10-POINT	1 A/R*
	401156-12	.SOCKET, 12-POINT	1 A/R*
	401156-16	.SOCKET, 16-POINT	1 A/R*
	401156-18	.SOCKET, 18-POINT	1 A/R*
	401156-20	.SOCKET, 20-POINT	1 A/R*
	401156-24	.DUST COVER, 24-POINT	1 A/R*
1	57055	.TERMINAL BLOCK, SIGNAL INPUT CONNECTION	‡
2	50966	.COVER, TOP	1
3	50966	.COVER, BOTTOM	1
4	50896	.POST, SPACER	4
5	50897	.POST, SPACER	4
6	50898	.SPACER, MOUNTING	4
7	50964	.INSULATION, TOP AND BOTTOM COVERS	2
8	50963	.INSULATION, TOP AND BOTTOM COVERS	2
9	50921	.PANEL, INPUT (ALUMINUM)	1
10	43136	.TERMINAL, INSULATED	2 †
11	ND40074-4	.STRIP, TERMINAL	1
12	50972	.CABLE ASSEMBLY (4-CONDUCTOR, SHIELDED)	1 θ
13	50965	.LABEL	1
Rc	54469	.RESISTOR, TEMPERATURE COMPENSATING	1 θ

¶ INCLUDES NUMBER-OF-POINTS PLUG P301.
* REFER TO INSTRUMENT DATA SHEET.
§ EXCLUDES NUMBER-OF-POINTS PLUG P301 (FOR FIXED NUMBER-OF-POINTS).
π USED ONLY ON INPUT PANELS 50890 AND 50936.
** NOT ILLUSTRATED; USED ONLY ON INPUT PANELS 50890 AND 50936.
‡ 4 USED ON INPUT PANELS 50890 AND 50936; 4 USED ON INPUT PANEL 50970 WHEN FIXED NUMBER-OF-POINTS ARE GREATER THAN 12; 2 USED ON INPUT PANEL 50970 WHEN FIXED NUMBER-OF-POINTS ARE LESS THAN 13.
† 4 USED ON DUAL-RANGE INPUT PANEL.
θ 2 USED ON DUAL-RANGE INPUT PANEL.

FIGURE 4.19. UNIVERSAL SIGNAL INPUT PANEL PARTS IDENTIFICATION.

OTHER RECORDER OPTIONS (CONT'D)

Potentiometric Multi-Range (Internally Mounted)	Permits Manual Selection of Any of These DC MV Ranges: -0.5 to +0.5, 0 to 1, -5 to +5, 0 to 10, -10 to +10, 0 to 20, -20 to +20, 0 to 40, -25 to +25, 0 to 50, -50 to +50 and 0 to 100.
Potentiometric Variable Span and Zero for Thermocouples (Internally Mounted)	Permits Any Desired Temperature Range (Within The Limits of NBS Circular 561 and Minimum Span of 3MV) to be Recorded for Any One Type of Thermocouple Such as E, J, K, R, S, T.
Potentiometric Variable Span and Zero for Millivolts (Internally Mounted)	Zero Continuously Adjustable From 0 to ±100MV DC for Any Span Setting. Span Continuously Adjustable from 1 to 100MV DC.
Extra Switch Deck	A two-Pole, 24-Position Switch Deck May be Added to the Selector Switch Assembly to Provide External Electrical Identification of the Point Being Printed.
48-Point Recorder	Contains Two, 24-Point Signal Input Panels to Provide a Recording of up to 48 Inputs.
Print-On-Alarm	Allows Recorder to Scan all Input Points, but Prints and Advances Chart Only on Points That Exceed an Alarm Setpoint.

SECTION II-STRIP CHARTS

ESTERLINE ANGUS CHARTS FOR THE MODEL E1124E MULTIPOINT RECORDER ARE 11 INCHES WIDE AND HAVE CALIBRATED ANALOG CHANNEL WIDTHS OF 10 INCHES. EACH CHART BEARS THREE SETS OF TIME NUMBERS SO THE SAME CHART CAN BE USED FOR 1, 2, AND 3 INCH-PER-HOUR SPEEDS.

THE CENTER TIME NUMBERS ARE FOR 1 INCH-PER-HOUR SPEEDS AND ARE MARKED A.M. AND P.M. THE LEFT TIME NUMBERS ARE FOR 2 INCH-PER-HOUR SPEEDS, AND THE RIGHT TIME NUMBERS ARE FOR 3 INCH-PER-HOUR SPEEDS. TIME NUMBERS APPEAR EVEPY 1, 2, AND 3 INCHES ON THE 120-FOOT CHARTS.

ALSO ADDING TO THE CONVENIENCE OF USING THESE CHARTS ARE FOOT-REMAINING NUMBERS WHICH APPEAR EVERY 12 INCHES IN THE LEFT MARGIN OF THE CHART. A NOTE ON THE CHART INDICATES WHEN 10 FEET REMAIN. WHEN ONLY 3 FEET REMAIN, "THE END" IS CLEARLY PRINTED ACROSS THE FACE OF THE CHART.

THE RIGHT MARGIN OF THE CHART CAN ACCOMMODATE AN EVENT PEN SO THAT EVENTS WHICH HAVE A BEARING ON THE ANALOG RECORD MAY BE NOTED. ONE-EIGHTH INCH CHART-DRIVE PERFORATIONS AT 1/4-INCH INTERVALS ARE LOCATED IN THE LEFT MARGIN.

CHART RULINGS ARE OF FOUR PRINCIPAL WEIGHTS. THE CARDINAL RULING BEARS THE RANGE NUMBER AND THE SEMI-CARDINAL RULING DOES NOT. MINOR RULINGS ARE THE LIGHTER LINES ON MOST CHARTS.

SERIES "E" CHARTS MAY BE ORDERED WITH SPECIAL RULINGS, RANGES, CAPTIONS, AND TIME NUMBERS. MULTI-COLOR CHARTS ARE ALSO AVAILABLE. CONSULT YOUR LOCAL ESTERLINE ANGUS REPRESENTATIVE.

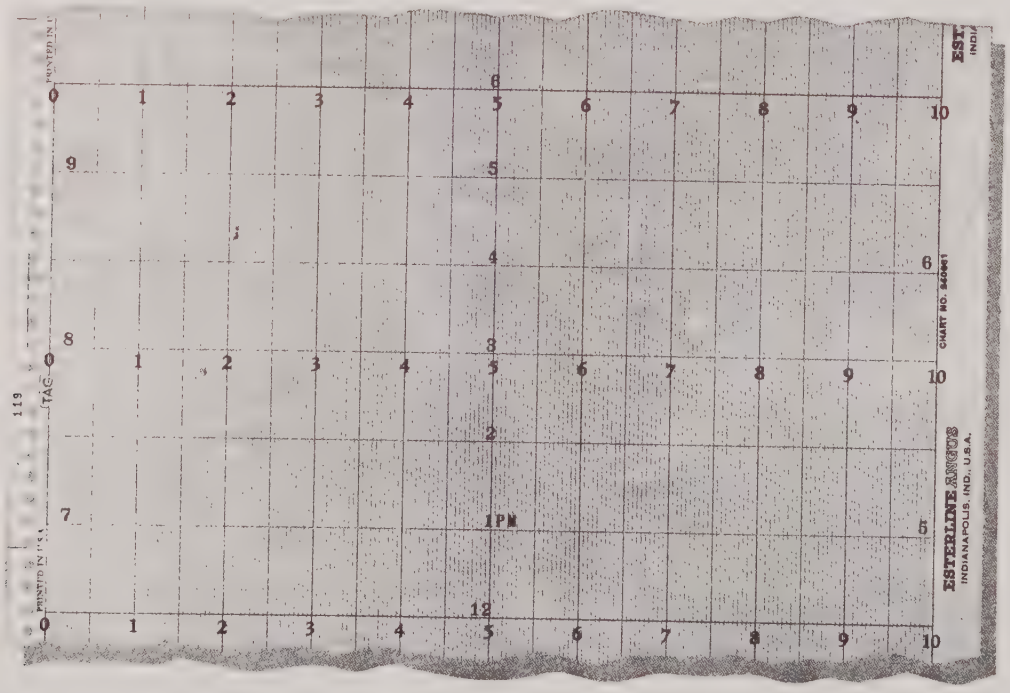


FIGURE 5.1. CHART NO. 240661 REDUCED ONE-HALF SIZE. ITS RANGE IS 0 TO 10 WITH 11 CARDINAL (NUMBERED) DIVISIONS AND 200 MINOR DIVISIONS.

NOTE: CONTACT YOUR LOCAL ESTERLINE ANGUS SERVICE REPRESENTATIVE FOR CHART CATALOG INFORMATION. ESTERLINE ANGUS AUTHORIZED REPRESENTATIVES ARE LISTED ON A SEPARATE PAGE FOUND IN THE APPENDIX SECTION OF THIS MANUAL.

SECTION III
WRITING SYSTEM SUPPLIES AND ACCESSORIES

ANALOG DRAG PEN ASSEMBLY KITS

DESCRIPTION	PART NUMBER
Analog Drag Pen Assembly Kit for Red-Ink Writing Consists of: Analog Drag Pen Assembly Red-Inking Kit	51051-1 51050 61219-1
Analog Drag Pen Assembly Kit for Green-Ink Writing Consists of: Analog Drag Pen Assembly Green-Inking Kit	51051-2 51050 61219-2
Analog Drag Pen Assembly Kit for Black-Ink Writing Consists of: Analog Drag Pen Assembly Black-Inking Kit	51051-3 51050 61219-3

EVENT PEN KITS

DESCRIPTION	PART NUMBER
Event Pen Kit for Red-Ink Writing Consists of: Event Pen Assembly Red-Inking Kit	61245-1 61244* 61219-1
Event Pen Kit for Green-Ink Writing Consists of: Event Pen Assembly Green-Inking Kit	61245-2 61244* 61219-2
Event Pen Kit for Black-Ink Writing Consists of: Event Pen Assembly Black-Inking Kit	61245-3 61244* 61219-3

INKING KITS (FOR ANALOG and/or EVENT PEN)

DESCRIPTION	PART NUMBER
Red-Inking Kit Consists of: 1 Pen Filler 1 Pen Point Cleaner 4 Red-Ink Cartridges	61219-1 61499-A 16805027-001 21653-1
Green-Inking Kit Consists of: 1 Pen Filler 1 Pen Point Cleaner 4 Green-Ink Cartridges	61219-2 61499-A 16805027-001 21653-2
Black-Inking Kit Consists of: 1 Pen Filler 1 Pen Point Cleaner 4 Black-Ink Cartridges	61219-3 61499-A 16805027-001 21653-2

*NOTE: Event Pen Assembly Includes Event Pen Element Part No. 61270;

SECTION IV
PRINTING SYSTEM SUPPLIES AND ACCESSORIES

UNICOLOR INK-PAD KITS*

DESCRIPTION	PART NUMBER
Red Ink-Pad Kit	51029-1
Green Ink-Pad Kit	51029-2
Blue Ink-Pad Kit	51029-3
Black Ink-Pad Kit	51029-4
Purple Ink-Pad Kit (Standard)	51029-5
Brown Ink-Pad Kit	51029-6

*Each Kit Consists of Two Unicolor Pads (In Plastic Bag) Packed in a Tin Container.

MULTICOLOR INK WHEEL KITS*

DESCRIPTION	PART NUMBER
2- Color Kit (Red, Green)	51100-2
3- Color Kit (Red, Green, Blue)	51100-3
4- Color Kit (Red, Green, Blue, Black)	51100-4
6- Color Kit (Red, Green, Blue, Black, Purple, Brown)	51100-6

*Each Kit consists of a set of six preassembled ink wheel assemblies packed in a carton.

VIALS OF MULTICOLOR INK PADS*

DESCRIPTION	PART NUMBER
Vial of Red Ink Pads	51030-1
Vial of Green Ink Pads	51030-2
Vial of Blue Ink Pads	51030-3
Vial of Black Ink Pads	51030-4
Vial of Purple Ink Pads	51030-5
Vial of Brown Ink Pads	51030-6

*Each Vial Contains Twenty-Five Inked Pads of the Same Color.

UNICOLOR INK WHEEL ASSEMBLIES

(Includes Wheel Assembly Plus Pad)

DESCRIPTION	PART NUMBER
Ink Wheel Assembly (Red)	51027-1
Ink Wheel Assembly (Green)	51027-2
Ink Wheel Assembly (Blue)	51027-3
Ink Wheel Assembly (Black)	51027-4
Ink Wheel Assembly (Purple)	51027-5
Ink Wheel Assembly (Brown)	51027-6

MULTICOLOR INK WHEEL ASSEMBLIES

(Includes Wheel Assembly Plus Pads)

DESCRIPTION	PART NUMBER
2-Color Assembly (Red, Green)	51026-2
3-Color Assembly (Red, Green, Blue)	51026-3
4-Color Assembly (Red, Green, Blue, Black)	51026-4
6-Color Assembly (Red, Green, Blue, Black, Purple, Brown)	51026-6

SECTION V
MISCELLANEOUS SUPPLIES AND ACCESSORIES

LUBRICATION KIT

DESCRIPTION	PART NUMBER
Lubrication Kit, Complete	51429
Consists of: 1/2-Ounce Bottle of Oil	ND33601
1-Ounce Tube of Grease	407751
2-Ounce Tube of Grease	01599

PART 6
APPENDIX

GENERAL

PART 6 OF THIS MANUAL CONTAINS SUPPLEMENTAL INFORMATION COVERING OPTIONAL FEATURES OF THE MODEL E1124E MULTIPOINT RECORDER. THIS INCLUDES INSTRUCTIONS FOR ACCESSORY ATTACHMENTS AND ALL OF THE REQUIRED DOCUMENTATION FOR SPECIAL INSTRUMENT MODIFICATIONS REQUESTED BY THE PURCHASER.

WHEN APPLICABLE, THE APPENDIX WILL ALSO INCLUDE PRODUCTION CHANGE NOTICES WHICH WILL DESCRIBE THE LATEST DESIGN IMPROVEMENTS AS WELL AS CORRECTIONS FOR ANY TECHNICAL OR GRAMMATICAL ERRORS THAT MAY BE FOUND IN THE REST OF THE MANUAL.

THE DATA SHEET FOR YOUR RECORDER WILL BE FOUND IN A SEPARATE ENVELOPE BOUND IN THE BACK OF THE MANUAL. THIS DOCUMENT IS A CUSTOMIZED SPECIFICATION FORM THAT ACCURATELY DESCRIBES THE INSTRUMENT SUPPLIED.

REFER TO THE DATA SHEET FOR A DESCRIPTION OF YOUR INSTRUMENT, THE ACCESSORIES SUPPLIED, THE SERIAL NUMBER, AND ANY SPECIAL ASSEMBLY NUMBERS.

ATTENTION: DO NOT MISPLACE THE DATA SHEET; ALWAYS KEEP IT IN THE ENVELOPE PROVIDED.

PROGRAMMED PRINTING (STANDARD OPTION)

GENERAL INFORMATION

Programmed Printing is an optional feature incorporated into the input selection system of the Model E1124E Multipoint Recorder.

The major components which comprise the programmed printing option are shown in Figure 1 and are listed as follows:

(1) A selector switch assembly containing a program switch deck (Figure 2).

(2) Panel of twenty-four, 2-position, slide-type switches.

(3) Print motor.

(4) Gearbox assembly.

(5) Motor-reversing relay.

The basic function of the programmed printing option enables the operator to preselect the points (stations) which are desired to be either printed or skipped. The switches on the program switch panel are identified by numbers which correspond to the numbered point (station) terminals on the multiple-signal input panel (TB501). The switches corresponding to points (stations) which are desired to be printed are placed in the upward or PRINT position; switches corresponding to points (stations) which are desired to be skipped are placed in the downward or SKIP position.

As the selector switch automatically advances to make each point (station) selection, the points (stations) which are programmed to "PRINT" are printed on the chart in the normal manner at a print frequency specified on the instrument DATA SHEET. In a like manner, the points (stations) which are programmed to "SKIP" are deleted or skipped at a constant rate of .2 second per point regardless of the print frequency. In the SKIP mode of operation, the printhead also remains idle so that the printed record only includes the measured values of the points (stations) which were programmed for printing.

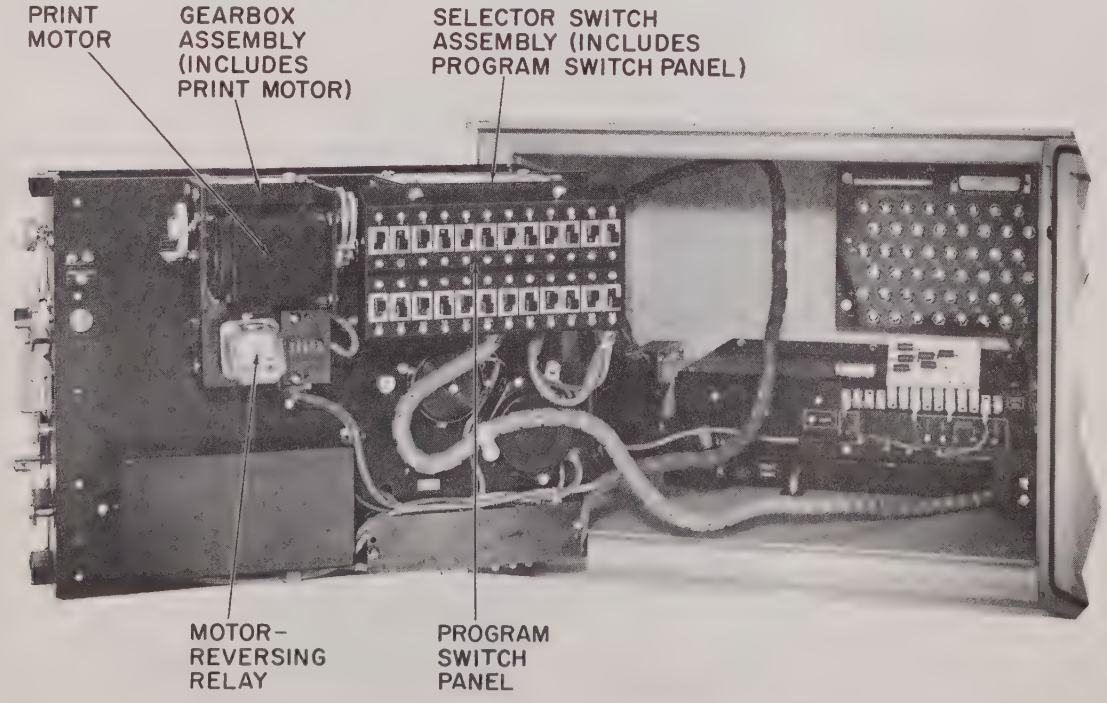


FIGURE 1. MAJOR COMPONENTS INVOLVED IN OPERATION OF PROGRAMMED PRINTING OPTION.

APPLICATION OF PROGRAMMED PRINTING

Applications of the programmed printing option are varied and depend on the user's requirements. Typical situations are listed as follows:

(1) Rapid change of the total number-of-points (-stations) recorded by the instrument is provided without the requirement of performing the procedures involved in changing the number-of-points (-stations).

NOTE: The procedures for changing the number-of-points are described in PART 3, SECTION III (Mechanical Maintenance Section) of this manual.

Any desired number-of-points can be provided at any time by means of the PRINT-SKIP switches, thus saving the purchase of individual point change conversion kits and the time involved in the conversion procedures. In addition, conversion can be made to point (station) numbers for which no kits are furnished.

(2) The clarity of the chart record may be improved by skipping unnecessary points.

(3) Points with defective sensing elements may be skipped, thus removing erroneous data from the chart record.

(4) Recording operations requiring numerous measurements at start-up or during certain periods may be readily converted to record only critical or changing points. Skipped points can be periodically printed as desired.

(5) During recording operations, points that begin to change rapidly may be printed at a faster time interval by skipping unchanging or slowly changing points.

(6) Remote selection of points to be skipped may be made at a distance from the recorder by remote mounting of the program switch panel. (Consult factory.)

TECHNICAL SPECIFICATIONS

The technical specifications for a multipoint recorder equipped with the programmed printing option remain the same as the specifications which are listed in PART 3, SECTION I (Description) of this manual for the basic (no options employed) multipoint recorder--except for the print frequencies which are shown in the following table:

* STANDARD PRINT FREQUENCIES

† BASIC PRINT FREQUENCY (Seconds/Point, or Time Between Print-Outs)	1.0	1.5	3	6	7.5	15
θ PRINT RATE WITH MANUAL SHIFT OF GEAR AND PINION ASSEMBLY (Seconds/Point, or Time Between Print-Outs)	4	6	12	24	30	60

* The Print Frequency of a Particular Instrument is Specified on the DATA SHEET. Time Values Shown are for 60Hz-Powered Instruments. Time Values Increase 1.2 Times on 50Hz-Powered Instruments.

† Gear and Pinion Assembly in Gearbox Positioned in Fast-Speed Ratio as Shown in Fig. 5A.

θ Gear and Pinion Assembly in Gearbox Positioned in Slow-Speed Ratio as Shown in Fig. 5B.

PRINCIPLES OF OPERATION

The prerequisites of the programmed printing operation are as follows:

(1) SERVO (BALANCE) ACTION AND PRINTING MUST BE SUSPENDED DURING THE SKIP OPERATION.

(2) SKIPPING MUST BE FASTER THAN THE NORMAL MEASURING (SERVO) RESPONSE TIME AND THE PRINTING FREQUENCY.

(3) PROPER PRINT WHEEL ADVANCE MUST BE ASSURED DURING SKIPPING WITHOUT THE HELP NORMALLY RECEIVED FROM THE PRINTING MOTION. REFER TO SUBJECT HEADING ENTITLED "MECHANICAL ANALYSIS OF PRINT CYCLE" IN PART 3, SECTION I OF THIS MANUAL.

(4) THE FIRST POINT (STATION) RECORDED AFTER A SKIP OPERATION MUST BE MEASURED WITHOUT LOSS OF ACCURACY. THIS CONDITION MEANS THAT THE POINT MUST HAVE THE FULL AND NORMAL PRINT-FREQUENCY INTERVAL TO DRIVE TO BALANCE AND THAT NO ERROR SHOULD EXIST IN THE POSITION OF THE SELECTOR SWITCH AFTER A SKIP OPERATION.

TWO MAJOR DESIGN FEATURES ARE COMBINED TO ESTABLISH THE PRINCIPLES OF THE PROGRAMMED PRINTING OPERATION. THESE FEATURES ARE AS FOLLOWS:

(1) THE POWER TO THE PRINT MOTOR IS CONTROLLED THROUGH A RELAY. WITH THE RELAY DE-ENERGIZED, THE MOTOR RETAINS ITS NORMAL DIRECTION OF ROTATION AND CAUSES THE PRINT CYCLE TO BE ACTUATED IN THE NORMAL MANNER. WHEN THE RELAY ENERGIZES, THE MOTOR REVERSES ITS NORMAL DIRECTION OF ROTATION--THE RESULT OF WHICH STOPS THE PRINTING OPERATION AND STARTS THE SKIPPING OPERATION. THE MOTOR-REVERSING RELAY IS CONTROLLED BY A SERIES-CIRCUIT SWITCHING ARRANGEMENT CONSISTING OF THE SWITCHES ON THE PROGRAM SWITCH PANEL, THE PROGRAM SWITCH DECK IN THE SELECTOR SWITCH ASSEMBLY, AND THE SKIP DELAY SWITCH IN THE GEARBOX ASSEMBLY (SEE FIGURE 2).

(2) THE GEARBOX (FIGURE 2) CONTAINS TWO OVER-RUNNING CLUTCHES, EACH OF WHICH ONLY TRANSMITS THE DRIVE IN ONE DIRECTION AND SLIPS IN THE OTHER DIRECTION. ONLY ONE CLUTCH AT A TIME CAN TRANSMIT THE DRIVE. THE CLUTCH WHICH TRANSMITS THE DRIVE AT A GIVEN TIME IS DETERMINED BY THE DIRECTION OF ROTATION OF THE PRINT MOTOR. THE DRIVING AND

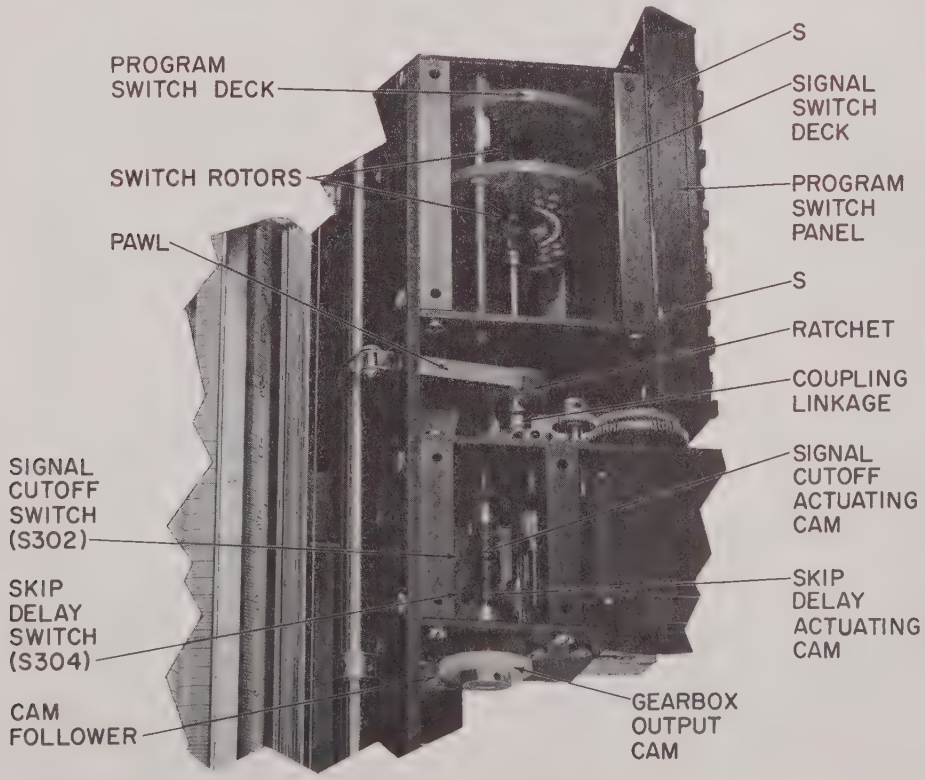


FIGURE 2. INTERNAL VIEW OF SELECTOR SWITCH ASSEMBLY AND GEARBOX ASSEMBLY WITH TOP COVERS REMOVED.

DRIVEN MEMBERS OF THE CLUTCHES ARE IDENTIFIED IN FIGURE 4. DRIVE IS TRANSMITTED WHEN THE DRIVING MEMBER ROTATES IN A DIRECTION TO TIGHTEN THE SLIP SPRING ON BOTH MEMBERS.

ELECTRICAL CIRCUIT DESCRIPTION
(REFER TO FIGURES 3 AND 13)

THE PROGRAM SWITCH PANEL (FIGURE 1) PROVIDES A 2-POSITION SLIDE SWITCH FOR EACH OF THE 24 PHYSICAL POINTS (STATIONS) OF THE RECORDER. AS SHOWN IN FIGURE 3, ONE OF THE TERMINALS ON EACH OF THE PROGRAM SWITCHES IS WIRED "IN COMMON" TO THE "HOT" OR "LINE" SIDE OF THE AC SOURCE. THE OTHER ACTIVE TERMINAL ON EACH SWITCH IS CONNECTED TO ITS RESPECTIVE POINT (STATION) CONTACT ON THE 24-CONTACT PROGRAM SWITCH DECK. THE PROGRAM SWITCH DECK IS OF THE SHORTING OR MAKE-BEFORE-BREAK (MBB) TYPE WHICH ENABLES IT TO MAINTAIN ELECTRICAL CONTINUITY BETWEEN A SERIES OF POINTS CHOSEN TO BE SKIPPED. THE ROTOR OF THE PROGRAM SWITCH DECK IS MECHANICALLY COUPLED TO THE SELECTOR SWITCH SHAFT AND MOVES IN UNISON WITH THE ROTORS ASSOCIATED WITH ALL OTHER SWITCH DECKS WHICH MAY BE INCORPORATED INTO A PARTICULAR SELECTOR SWITCH ASSEMBLY.

"PRINT MODE" CIRCUIT DESCRIPTION

AS SHOWN IN FIGURE 3, ASSUME THAT THE PROGRAM SWITCH FOR POINT (STATION) NUMBER 1 IS IN THE PRINT POSITION. UNDER THIS CONDITION, THE PROGRAM SWITCH PRESENTS AN OPEN CIRCUIT TO THE "LINE" SIDE OF THE AC SOURCE AND ELIMINATES POWER FROM BEING APPLIED TO THE MOTOR-REVERSING RELAY (K301) THROUGH THE SERIES-SWITCHING CIRCUITRY CONSISTING OF THE PROGRAM SWITCH DECK AND THE CAM-ACTUATED, SKIP DELAY SWITCH (S304).

WHEN THE ROTOR OF THE PROGRAM SWITCH DECK ADVANCES TO POINT (STATION) NUMBER 1 AND WITH THE SKIP DELAY SWITCH ACTUATED TO THE CLOSED POSITION, THE MOTOR-REVERSING RELAY REMAINS IN THE DE-ENERGIZED POSITION TO PERMIT THE NORMAL FUNCTION OF THE PRINTING AND POINT-SELECTION CYCLE.

WITH THE RELAY IN THE DE-ENERGIZED OR "PRINT" MODE, THE "LINE" SIDE OF THE AC SOURCE IS DIRECTLY APPLIED THROUGH RELAY CONTACTS 11 AND 8 TO WINDING #1 OF THE PRINT MOTOR. AT THE SAME TIME, THE "LINE" SIDE OF THE AC SOURCE IS ALSO FED THROUGH SERIES CAPACITOR C302 TO APPLY A LEADING PHASE TO WINDING #2 OF THE PRINT MOTOR. THE PHASE OF WINDING #2 LEADING THE PHASE OF WINDING #1 ESTABLISHES THE "PRINT DIRECTION" OF MOTOR ROTATION. THIS ROTATION, WHEN COUPLED THROUGH THE GEARBOX, MECHANICALLY ACTUATES THE NORMAL PRINT MODE OF OPERATION.

NOTE: REFER TO SUBJECT HEADING ENTITLED "MECHANICAL ANALYSIS OF PRINT CYCLE" IN PART 3, SECTION I OF THIS MANUAL FOR A DETAILED MECHANICAL DESCRIPTION OF THE PRINTING CYCLE.

"SKIP MODE" CIRCUIT DESCRIPTION

AS SEEN IN FIGURE 3, ASSUME THAT THE PROGRAM SWITCH FOR POINT (STATION) NUMBER 2 IS IN THE SKIP POSITION. IN THIS CASE, THE PROGRAM SWITCH CONNECTS THE "LINE" SIDE OF THE AC SOURCE TO POINT (STATION) NUMBER 2 ON THE PROGRAM SWITCH DECK.

WHEN THE ROTOR OF THE PROGRAM SWITCH DECK ADVANCES TO POINT (STATION) NUMBER 2, THE "LINE" SIDE OF THE POWER SOURCE IS SERIES-CONNECTED THROUGH THE ROTOR ARM TO THE SKIP DELAY SWITCH (S304). AT THIS POINT, HOWEVER, IT CAN BE SEEN THAT POWER TO THE RELAY CANNOT BE COMPLETED UNTIL THE SKIP DELAY SWITCH HAS BEEN CLOSED.

THE CLOSING OF THE SKIP DELAY SWITCH AND THE SUBSEQUENT ENERGIZATION OF THE RELAY (HENCE, THE DIRECTION REVERSAL OF THE MOTOR) IS CONTROLLED BY THE SKIP DELAY ACTUATING CAM (SEE FIGURE 2). ENERGIZATION OF THE RELAY (DIRECTION REVERSAL OF THE PRINT MOTOR) MUST BE PRECISELY TIMED AND CANNOT BE ALLOWED TO IMMEDIATELY TAKE PLACE WHEN THE ROTOR OF THE PROGRAM SWITCH DECK FIRST MAKES CONTACT WITH THE POINT (STATION) PROGRAMMED TO BE SKIPPED.

IF DIRECTION REVERSAL OF THE PRINT MOTOR WAS ALLOWED TO TAKE PLACE IMMEDIATELY, THE CAM FOLLOWER WOULD NEVER BE DRIVEN OUT OF THE NOTCH IN THE OUTPUT CAM; CONSEQUENTLY, THE NECESSARY POINT (STATION) ADVANCE WOULD NOT BE COMPLETED BEFORE THE SKIPPING ACTION WAS INITIATED. IN ADDITION, THIS SITUATION WOULD ALSO PERMIT THE PRINTHEAD TO REMAIN IN THE PRINTING POSITION (PRINT WHEEL IN CONTACT WITH CHART)--A CONDITION WHICH CANNOT BE TOLERATED WHEN SKIPPING ACTION HAS BEGUN. THEREFORE, THE REVERSAL DIRECTION OF THE PRINT MOTOR MUST BE DELAYED UNTIL THE CAM FOLLOWER IS DRIVEN OUT OF THE CAM NOTCH SO THAT (1) THE ROTORS IN THE SELECTOR SWITCH FULLY ADVANCE TO THE NEXT POINT (STATION) POSI-

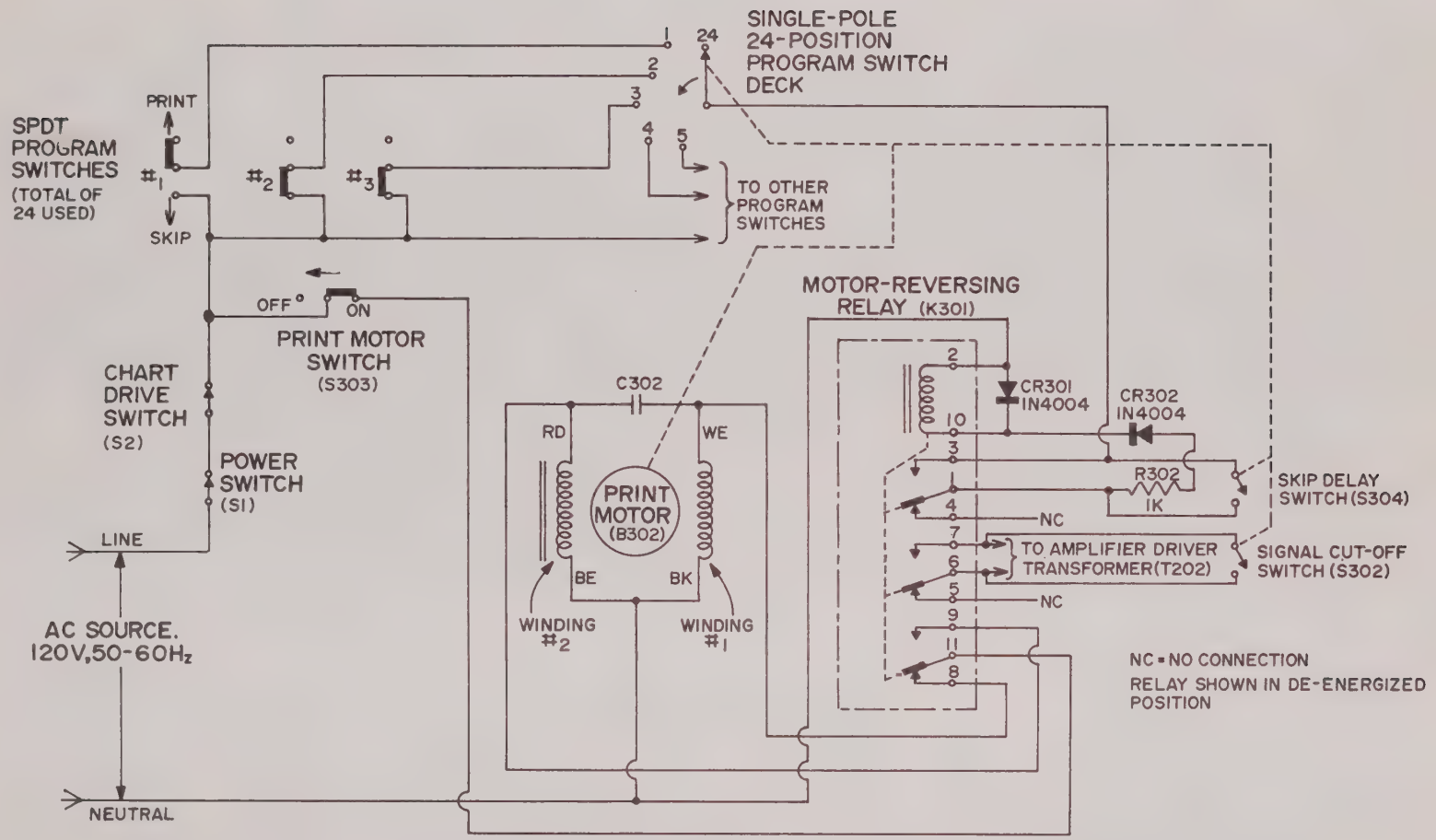


FIGURE 3. SIMPLIFIED SCHEMATIC OF PROGRAMMED PRINTING CIRCUITRY.

tion and (2) the printhead raises to its normal upper-rest position.

NOTE: Refer to topic heading "Service Adjustments" in this supplement for adjustment procedures of the skip delay actuating cam.

When the skip delay switch is cam-actuated to the closed postion, the "line" side of the AC source is fed through the series voltage-dropping resistor R302 and is applied to diode rectifier CR302. A pulsating 40-volt DC output from CR302 energizes the relay. Diode CR301 serves as arc-suppression protection for the contacts of the program switch deck.

With the relay energized, the following circuits are completed through the relay contacts:

(1) The "line" side of the AC source is applied through relay contacts 11 amd 9 to windings #2 and #1 of the print motor. Winding #2 is now directly connected across the AC source and has a lagging phase; winding #1 is connected in series with capacitor C302 and has a leading phase. The reversal of the phases in windings #2 and #1 causes a reversal in the direction of the print motor, thus establishing the "skip direction" of motor rotation.

(2) An AC holding voltage is applied through contacts 3 and 1 to keep relay energized during the skip mode of operation.

(3) The servo measurement signal in the amplifier is shorted through relay contacts 6 and 7. This action serves to electrically clamp the balance (servo) motor in place so that the printhead carriage mechanism is stopped from trying to follow each value of the various points (stations) as they are rapidly being skipped.

The "skip direction" of motor rotation, when coupled through the gearbox, directly drives the rotors in the selector switch at a high speed (.2 second per point). When the rotor associated with the program switch deck advances to a point (station) which has been programmed to the PRINT position, the circuit to the motor-reversing relay is again opened. Thereafter, the print motor reverses to its "print direction" of rotation and the gearbox output cam resumes its rotation in the normal counterclockwise direction to actuate the printing and point-selection cycle.

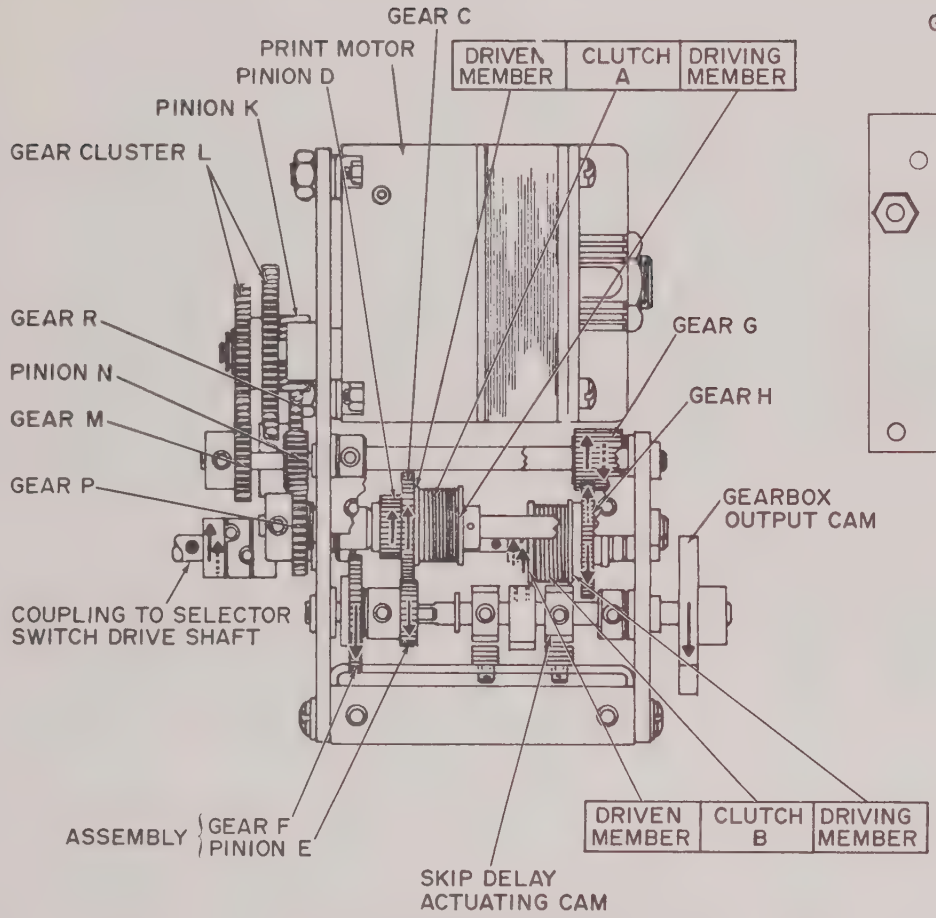
MECHANICAL OPERATION OF GEARBOX
(Refer to Figure 4)

The drive from the print motor shaft is coupled to the input side of the gearbox through the following gear train: motor pinion K simultaneously drives intermediate gear cluster L and gear R; gear cluster L then drives intermediate gear M; gear M, being mounted on the same shaft with pinion N, imparts the drive to pinion N; finally, the drive from pinion N is coupled to the gearbox input through gear P.

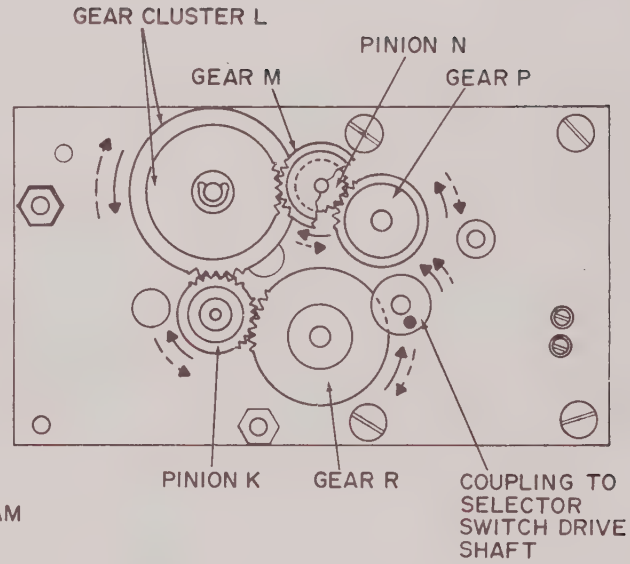
The variable items which determine the rotation per-unit-time (print frequency) of the gearbox output cam consist of gear cluster L, gear M, and the engagement position of the gear and pinion assembly with other gearing within the gearbox. The print motor, pinions K and N, gears P snd R, and all the other gearing within the gearbox remain the same for all print frequencies. Refer to instrument DATA SHEET for specified print frequency furnished on a particular recorder. The procedures for changing the print frequency are described under topic heading "Changing Print Frequency" in this supplement.

The function of the gearbox during the print mode of operation is to provide rotation of the gearbox output cam so that the printing action takes place every time the cam follower (Figure 2) falls into the notch on the output cam. The ensuing mechanical activity, which is also expended during each revolution of the output cam, actuates the pawl and the ratchet (Figure 2) to advance the rotors in the selector switch assembly to the next physical point (station).

When the motor reverses its direction of rotation, the gearbox senses and detects this change in direction. This detection (1) stops the rotation of the output cam, the result of which stops the printing operation and (2) starts the skip mode of operation by rotating the selector switch drive shaft via the coupling linkage (Figure 2) that exists between the gearbox and the selector switch assembly. The rotors in the



TOP VIEW OF GEARBOX



INPUT GEAR-TRAIN DRIVE TO GEARBOX

LEGEND

- PRINT MODE ROTATIONAL DIRECTION
- SKIP MODE ROTATIONAL DIRECTION
- DRIVEN BY MEANS OF PAWL-AND-RATCHET ACTUATION DURING PRINT MODE; DRIVEN BY CLUTCH B DURING SKIP MODE.

FIGURE 4. DETAILS OF GEARBOX OPERATION.

SELECTOR SWITCH ASSEMBLY, THE PRINT WHEEL AND INK WHEEL ASSEMBLIES, AND THE POINT (STATION) INDICATOR WHEEL ARE ALL ROTATED AT A SKIPPING RATE OF .2 SECOND PER POINT.

Unidirectional Clutch Operation (Refer to Figure 4)

The rotational direction change of the print motor is detected in the gearbox by the two unidirectional clutches, clutch A and clutch B. These clutches consist of two rotating members, one termed the driving member and one termed the driven member. The two members are connected together by a coiled (clutch) spring. Applying a rotation to the driving member of the clutch in one direction tightens (engages) the clutch spring to cause the driven member to rotate in the same direction. Reversing the direction of rotation to the driving member tends to unwind or loosen (disengage) the clutch spring so that the driven member is not gripped; consequently, the driven member does not rotate.

Mechanical Operation of Gearbox During Print Mode (Refer to Figure 4)

The mechanical operation is as follows:

(1) The drive on gear P is transmitted to the driving member of clutch A. The direction of rotation is such that clutch A engages. Gear C or pinion D, which is attached to the driven member of clutch A, drives either pinion E or gear F. The drive on pinion E or gear F is coupled to the gearbox output cam to actuate the printing cycle.

NOTE: Due to the selection feature of changing the print frequency, gear C may be engaged with pinion E, or pinion D may be engaged with gear F. As shown in Figure 4, gear C is driving pinion E (fast-speed ratio selection). Refer to topic heading "Changing Print Frequency" in this supplement.

(2) The directional drive on gear R is also coupled through its associated shaft to gear G. Gear G drives gear H in a direction so that clutch B remains disengaged. With clutch B disengaged, driven member of clutch B does not drive. However, since the driven member of clutch B is coupled to the selector switch shaft, the driven member and its associated coupling moves in the direction indicated by the solid-line arrow whenever the selector switch is advanced to other physical points (stations). This intermittent motion is not an output of clutch B but reflects the normal pawl-and-ratchet advance of the selector switch as produced by the rotation of the gearbox output cam during the printing cycle.

Mechanical Operation of Gearbox During Skip Mode (Refer to Figure 4)

The mechanical operation is as follows:

(1) Reversal direction of the print motor causes a reversal in the direction of gear P. This change in direction causes clutch A to disengage. With clutch A disengaged gear C and pinion D remain motionless. Therefore, no transmission is delivered to pinion E or gear F, thus stopping the rotation of the gearbox output cam. The stopping point of the output cam is determined by the adjustment of skip delay actuating cam (see "Service Adjustments" in this supplement).

(2) The directional drive on gear R is also coupled through its associated shaft to gear G. Gear G drives gear H in a direction so that clutch B is engaged. With clutch B engaged, driven member of clutch B transmits high-speed drive to the selector switch via the coupling between the gearbox and the selector switch assembly. The rotors in the selector switch assembly, the print wheel and ink wheel assemblies, and the point (station) indicator wheel are all rotated at a skipping rate of .2 second per point.

Complete Description of "Skip" Cycle

Assume that the program switch for point (station) number 3 is in the SKIP position and all other program switches are set in the PRINT position on a recorder equipped with a 24-point input selection system (number-of-points socket = 24).

The description is as follows:

(1) Rotor of program switch deck touches point contact 3 and applies "line"

VOLTAGE TO ONE SIDE OF THE SKIP DELAY SWITCH AND TO CONTACT 3 OF THE MOTOR-REVERSING RELAY. THIS ACTION TAKES PLACE AS CAM FOLLOWER IS BEING DRIVEN OUT OF THE CAM NOTCH ON THE PREVIOUS PRINT CYCLE.

(2) SHORTLY AFTER CAM FOLLOWER IS DRIVEN OUT OF CAM NOTCH, SKIP DELAY SWITCH CLOSES AND MOTOR-REVERSING RELAY IS ENERGIZED. PRINT MOTOR REVERSES ITS DIRECTION OF ROTATION.

(3) CLUTCH A DISENGAGES AND GEARBOX OUTPUT CAM STOPS TURNING. RELAY REMAINS ENERGIZED THROUGH AC HOLDING CONTACTS 3 AND 1 OF RELAY. AMPLIFIER SERVO MEASUREMENT SIGNAL IS SHORTED THROUGH CONTACTS 6 AND 7 OF RELAY.

(4) CLUTCH B ENGAGES AND TRANSMITS HIGH-SPEED DRIVE TO THE SELECTOR SWITCH ASSEMBLY, THE PRINT WHEEL AND INK WHEEL ASSEMBLIES, AND THE POINT (STATION) INDICATOR WHEEL. POINT (STATION) NUMBER 3 IS SKIPPED FROM THE PRINTED RECORD.

(5) WHEN ROTOR OF PROGRAM SWITCH DECK ADVANCES TO POINT CONTACT 4, "LINE" VOLTAGE IS INTERRUPTED FROM RELAY AND RELAY DE-ENERGIZES. PRINT WHEEL ADVANCES TO POINT (STATION) NUMBER 4. PRINT MOTOR REVERSES ITS DIRECTION OF ROTATION.

(6) AS MOTOR REVERSES, CLUTCH B DISENGAGES AND CLUTCH A ENGAGES TO DRIVE THE GEARBOX OUTPUT CAM FOR THE NORMAL PRINT CYCLE.

OPERATION

THE OPERATION OF A MULTIPOINT RECORDER EQUIPPED WITH THE PROGRAMMED PRINTING OPTION IS THE SAME AS THE STANDARD OR BASIC MULTIPOINT (NO OPTIONS EMPLOYED) EXCEPT FOR THE OPERATING INSTRUCTIONS WHICH PERTAIN SPECIFICALLY TO THE PROGRAMMED PRINTING OPTION. REFER TO PART 3, SECTION II (OPERATION) OF THIS MANUAL EXCEPT FOR THE OPERATING INSTRUCTIONS CONTAINED HEREIN.

OPERATING THE RECORDER ON LESS THAN 24 POINTS

THE TOTAL NUMBER-OF-POINTS (-STATIONS) WHICH MAY BE RECORDED IS DETERMINED BY THE NUMBER-OF-POINTS SOCKET WHICH IS INSERTED INTO THE MULTIPLE-SIGNAL INPUT PANEL. THIS FACTORY-PREWIRED POINTS (STATIONS) SOCKET ACCOMPLISHES THE CIRCUIT PARALLELING OF VARIOUS POINT (STATION) INPUT TERMINALS AS SHOWN IN TABLE 3.9 IN THE MECHANICAL MAINTENANCE SECTION (SECTION III) OF PART 3 IN THIS MANUAL.

THE RECORDER IS USUALLY OPERATED WITH A 24-POINT SOCKET INSERTED INTO THE MULTIPLE-SIGNAL INPUT PANEL TO PROVIDE A 24-POINT INPUT SELECTION. WITH A 24-POINT SELECTION, THE TOTAL NUMBER-OF-POINTS RECORDED IS CONTROLLED BY MEANS OF THE PROGRAM SWITCHES. IF THE RECORDER, AS AN EXAMPLE, WAS REQUIRED TO ONLY RECORD A TOTAL OF 6 POINTS, THE PROGRAM SWITCHES FOR 6 OF THE POINTS COULD BE SET TO THE PRINT POSITION AND THE REMAINING PROGRAM SWITCHES FOR THE OTHER 18 POINTS COULD BE SET TO THE SKIP POSITION.

IT MAY NOT BE POSSIBLE, HOWEVER, TO TOLERATE THE TOTAL TIME REQUIRED TO SKIP ALL 18 POINTS. IN THIS SITUATION, THE NUMBER-OF-POINTS SHOULD BE CHANGED TO 6 POINTS. INSTRUCTIONS FOR CHANGING THE NUMBER-OF-POINTS (-STATIONS) ARE CONTAINED IN THE MECHANICAL MAINTENANCE SECTION (SECTION III) OF PART 3 IN THIS MANUAL. POINT SOCKETS ARE AVAILABLE FOR 2-, 3-, 4-, 6-, 8-, 10-, 12-, 16-, 18-, 20-, AND 24-POINT SELECTION.

CHANGING THE NUMBER-OF-POINT SELECTION TO LESS THAN 24 POINTS REQUIRES A DIFFERENT PROCEDURE IN THE SET-UP OF THE PROGRAM SWITCHES. THIS PROCEDURE IS DESCRIBED UNDER TOPIC HEADING "PUTTING INSTRUMENT IN OPERATION" WHICH FOLLOWS.

PUTTING INSTRUMENT IN OPERATION

PERFORM SET-UP OF PROGRAM SWITCHES AS OUTLINED BELOW, AND THEN FOLLOW PROCEDURE OF STEPS DESCRIBED UNDER TOPIC HEADING "PUTTING INSTRUMENT IN OPERATION" IN PART 3, SECTION II (OPERATION) OF THIS MANUAL.

SET-UP OF PROGRAM SWITCHES

REFER TO TABLE 1 AND USE FOLLOWING EXAMPLE TO SET UP THE PROGRAM SWITCHES:

EXAMPLE: ASSUME NUMBER-OF-POINTS = 8, AND POINT 5 IS DESIRED TO BE SKIPPED.

PROCEDURE: RUN DOWN COLUMN HEADED "8-PT." AND NOTE THAT NUMBER (POINT OR STATION) 5 COMES UP OPPOSITE PROGRAM SWITCH NUMBERS 5, 13, AND 21. THEREFORE, TO SKIP POINT (STATION) 5 EVERY TIME IT COMES UP FOR PRINT-OUT, SET PROGRAM SWITCHES 5, 13, AND 21 TO SKIP POSITION. LEAVE ALL OTHER PROGRAM SWITCHES IN PRINT POSITION.

TABLE 1. INTERCONNECTION DATA FOR SETTING UP PROGRAM SWITCHES (POINT SELECTION LESS THAN 24).

PROG. SW. NUMBER	NUMBER-OF-POINTS (-STATIONS) SOCKET									
	2-PT.	3-PT.	4-PT.	6-PT.	8-PT.	10-PT.	12-PT.	16-PT.	18-PT.	20-PT.
1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2
3	1	3	3	3	3	3	3	3	3	3
4	2	1	4	4	4	4	4	4	4	4
5	1	2	1	5	5	5	5	5	5	5
6	2	3	2	6	6	6	6	6	6	6
7	1	1	3	1	7	7	7	7	7	7
8	2	2	4	2	8	8	8	8	8	8
9	1	3	1	3	1	9	9	9	9	9
10	2	1	2	4	2	10	10	10	10	10
11	1	2	3	5	3	5	11	11	11	11
12	2	3	4	6	4	6	12	12	12	12
13	1	1	1	1	5	1	1	13	13	13
14	2	2	2	2	6	2	2	14	14	14
15	1	3	3	3	7	3	3	15	15	15
16	2	1	4	4	8	4	4	16	16	16
17	1	2	1	5	1	5	5	5	17	17
18	2	3	2	6	2	6	6	6	18	18
19	1	1	3	1	3	7	7	7	7	19
20	2	2	4	2	4	8	8	8	8	20
21	1	3	1	3	5	9	9	9	9	9
22	2	1	2	4	6	10	10	10	10	10
23	1	2	3	5	7	5	11	11	11	11
24	2	3	4	6	8	6	12	12	12	12

TABLE 2. DATA FOR PRINT FREQUENCY SELECTION.

GEAR AND PINION ASSEMBLY POSITION	*PRINT FREQUENCY (SECONDS/POINT OR TIME BETWEEN PRINT-OUTS)	SKIPPING RATE ON DELETED POINTS (SECONDS/POINT)	DRIVING GEAR CLUSTER (COLOR)	DRIVEN GEAR (COLOR)	**CHANGE KIT
FIG. 5A	1.0 (BASIC)	.20	50859 (RED)	50855 (COPPER)	51498
FIG. 5B	4 (4 x BASIC)				
FIG. 5A	1.5 (BASIC)		51460 (ALUM.)	51456 (ALUM.)	51481
FIG. 5B	6 (4 x BASIC)				
FIG. 5A	3 (BASIC)		51461 (BLACK)	51457 (BLACK)	51482
FIG. 5B	12 (4 x BASIC)				
FIG. 5A	6 (BASIC)		51490 (ALUM.)	51379 (ALUM.)	51491
FIG. 5B	24 (4 x BASIC)				
FIG. 5A	7.5 (BASIC)		51462 (BLUE)	51458 (BLUE)	51483
FIG. 5B	30 (4 x BASIC)				
FIG. 5A	15 (BASIC		51463 (COPPER)	51459 (COPPER)	51484
FIG. 5B	60 (4 x BASIC)				

*REFER TO INSTRUMENT DATA SHEET FOR SPECIFIED PRINT FREQUENCY FURNISHED ON INSTRUMENT.

**KIT INCLUDES: 1-DRIVING GEAR CLUSTER, 1-DRIVEN GEAR, 1-RETAINING RING, AND 2-SETSCREWS.

Refer to Table 2 and select the required kit for the desired print-frequency change.

To Change Intermediate Drive Gears

Change drive gears as follows:

(1) Loosen the two screws (items S in Figure 2) which secure the program switch panel to the rear of the selector switch. Slide program switch panel to the right.

(2) Loosen two setscrews in hub of driven gear and remove driven gear from its shaft.

(3) Remove "E" retaining ring from driving gear cluster and remove gear cluster from its shaft.

(4) Install new driving gear cluster so that larger diameter gear engages the motor pinion. Retain gear cluster to shaft with "E" retaining ring.

(5) Install new driven gear on its shaft (hub out) so that mesh of gear is centered on the smaller diameter gear of the driving gear cluster. Tighten the two setscrews in hub against the flats of the shaft. Seal setscrews with "Glyptal" or an equivalent cement.

(6) Slide the program switch panel back to the left position and re-tighten the two mounting screws (S).

To Shift Position of Gear and Pinion Assembly

Refer to Table 2 for the desired speed selection with respect to a particular set of intermediate drive gears. Change speed selection as follows:

(1) Remove four screws from gearbox cover. Remove cover.

(2) Use hex (Allen) wrench and loosen two setscrews in the gear and pinion assembly (see Figure 6).

(3) Slide gear and pinion assembly to following positions:

Fast-speed ratio--See Figure 5A.
Slow-speed ratio--See Figure 5B.

After selecting the desired speed, retighten the two setscrews against the flats in cam shaft. Seal setscrews with "Glyptal" or an equivalent cement.

(4) Replace cover and secure with four mounting screws.

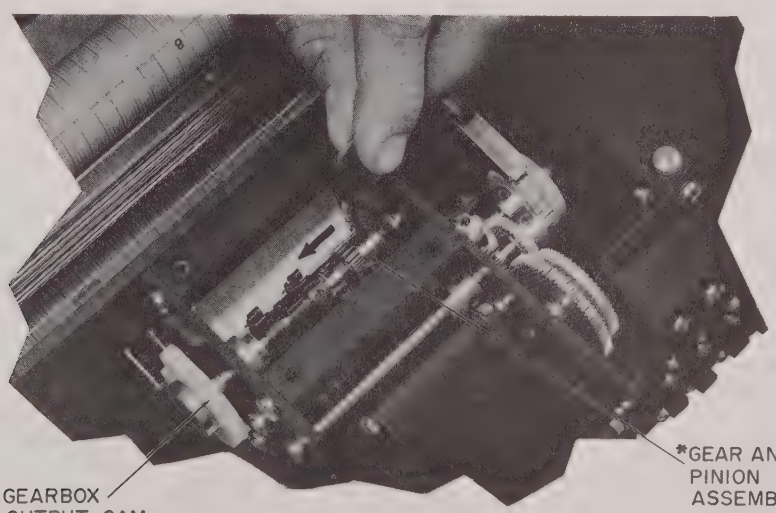

GEARBOX OUTPUT CAM
*GEAR AND PINION ASSEMBLY
*GEAR AND PINION ASSEMBLY IS SHOWN IN FAST-SPEED RATIO. SLOW-SPEED RATIO IS OBTAINED BY MOVING GEAR AND PINION ASSEMBLY IN THE DIRECTION OF THE ARROW.

FIGURE 6. CHANGING PRINT FREQUENCY.

MAINTENANCE

ALL OF THE MAINTENANCE PROCEDURES FOR A MULTIPOINT RECORDER EQUIPPED WITH THE PROGRAMMED PRINTING OPTION REMAIN THE SAME AS DESCRIBED IN PART 3, SECTION III (MAINTENANCE) OF THIS MANUAL EXCEPT FOR THE MAINTENANCE INSTRUCTIONS OTHERWISE CONTAINED HEREIN.

LUBRICATION

FOLLOW LUBRICATION INSTRUCTIONS AS SET FORTH IN MAIN BODY OF MANUAL (SEE PART 3, SECTION III). ALL LUBRICATION POINTS REMAIN THE SAME WHERE INDICATED IN FIGURE 3.13 OF PART 3, SECTION III WITH THE EXCEPTION OF THE GEARBOX LUBRICATION POINTS. THE GEARBOX LUBRICATION POINTS FOR THE PROGRAMMED PRINTING OPTION ARE SHOWN IN FIGURE 7 OF THIS SUPPLEMENT. REFER TO FIGURE 7 AND LUBRICATE WHERE INDICATED.

TROUBLESHOOTING

THE FOLLOWING TROUBLESHOOTING GUIDE IN TABLE 4 LISTS THE POSSIBLE TROUBLES WHICH MAY BE CAUSED BY MALFUNCTIONING COMPONENTS SPECIFIC TO THE PROGRAMMED PRINTING OPTION. TROUBLE SYMPTOMS WHICH ARE OF A GENERAL NATURE AND APPLY TO THE STANDARD (NO OPTIONS) RECORDER ARE FOUND IN TABLES 3.7 AND 3.13 IN PART 3, SECTION III (MAINTENANCE) OF THIS MANUAL.

TABLE 4. TROUBLESHOOTING GUIDE.

SYMPTOM	POSSIBLE CAUSE	REMEDY
(1) CHART DRIVE AND SERVO SYSTEM OPERATE BUT PRINT MOTOR IS INOPERATIVE.	PRINT MOTOR SWITCH IN OFF POSITION OR DEFECTIVE.	PLACE PRINT MOTOR SWITCH (S303) IN ON POSITION OR REPLACE SWITCH IF DEFECTIVE.
	FAULTY CONNECTION.	CHECK WIRING AND CONNECTIONS TO PRINT MOTOR. REFER TO POWER WIRING DIAGRAM IN FIGURE 13.
	DEFECTIVE MOTOR STARTING CAPACITOR (C302) OR RELAY (K301).	REPLACE DEFECTIVE COMPONENTS.
	DEFECTIVE PRINT MOTOR.	CHECK PRINT MOTOR (B302) AS INDICATED UNDER TESTING PROCEDURES. IF DEFECTIVE, REPLACE MOTOR AS DESCRIBED UNDER COMPONENTS REPLACEMENT.
(2) CAM FOLLOWER REMAINS IN NOTCH OF GEARBOX OUTPUT CAM CAUSING MOTOR TO STALL.	BINDING OF GEARS OR OTHER MECHANICAL ACTUATING COMPONENTS.	CHECK FOR BINDING OF GEARS: (A) IN GEAR-TRAIN DRIVE BETWEEN PRINT MOTOR AND INPUT SIDE OF GEARBOX AND (B) IN GEARBOX. ALSO CHECK FOR BINDING OF COMPONENTS WHICH ARE INVOLVED IN THE MOVEMENT AND ACTUATION OF THE PRINTING MECHANISM.
(3) PRINT MOTOR OPERATES, BUT THERE IS NO "PRINTING" OR "SKIPPING" ACTION.	LOOSE PINION K (FIGURE 4) ON MOTOR SHAFT.	TIGHTEN SETSCREW IN PINION K.

TABLE 4. TROUBLESHOOTING GUIDE (CONT'D.)

SYMPTOM	POSSIBLE CAUSE	REMEDY
(4) Print motor operates, but there is no "printing" action. "Skipping" action operates properly.	Loose gear or gears in input gear-train drive to gearbox (Figure 4).	Check gears M and P for looseness. Tighten setscrews in loose gears.
	Loose gear and pinion assembly (Figure 4) in gearbox.	Properly position gear and pinion assembly and then secure to its shaft. Refer to Table 2 and Figure 5.
	Loose gearbox output cam.	Tighten setscrews in output cam.
	Clutch A (Figure 4) slips.	Test operation of clutch as outlined under TESTING PROCEDURES. Replace clutch if defective. Refer to "Clutch Replacement" procedure as outlined under COMPONENTS REPLACEMENT
(5) Print motor operates, but there is no "skipping" action. "Printing" action operates properly	Loose gear R (Figure 4) in input gear-train drive to gearbox.	Tighten setscrew in gear R.
	Clutch B (Figure 4) slips.	Test operation of clutch as outlined under TESTING PROCEDURES. Replace clutch if defective. Refer to "Clutch Replacement" procedure as outlined under COMPONENTS REPLACEMENT.
	Malfunction in coupling linkage (Figure 4) between gearbox and selector switch assembly.	Check for loose or missing parts of coupling assembly. Tighten any loose parts.
(6) Cam follower rocks back and forth in notch of gearbox output cam during either the "print" cycle or the "skip" cycle. Print motor operates normally.	Loose gearbox output cam.	Retighten output cam.
(7) With recorder in "Print Mode," the printed record of measured values indicates periodic or sporadic paralleling (averaging) of adjacent signal inputs (the signal values of adjacent points	Defective sensing elements and/or incorrect connections of sensing elements.	Check all sensing elements and their connections.
SYMPTOM (7) cont'd.	Rotor of program switch deck lags too far behind rotor of signal switch	Refer to instructions outlined under topic heading entitled "Rotor
	CAUSE (7) cont'd.	REMEDY (7) cont'd.

TABLE 4. TROUBLESHOOTING GUIDE (CONT'D.)

SYMPTOM	POSSIBLE CAUSE	REMEDY
SYMPTOM (7) CONT'D. OR STATIONS ARE PRINTED ON TOP OF EACH OTHER). NOTE: PRINTING ACTION AND POINT (STATION) ADVANCE FUNCTION NORMALLY.	CAUSE (7) CONT'D. DECK, THE RESULT OF WHICH CAUSES ROTOR OF SIGNAL SWITCH DECK (MAKE-BEFORE-BREAK TYPE OF SIGNAL SWITCH DECK ONLY) TO BRIDGE ADJACENT SWITCH CONTACTS.	REMEDY (7) CONT'D. ADJUSTMENT OF PROGRAM SWITCH DECK" UNDER SERVICE ADJUSTMENTS.
(8) AN EXTRA POINT((STATION) IS SKIPPED AT TERMINATION OF THE "SKIP" CYCLE AND AT BEGINNING OF THE "PRINT" CYCLE; CAM FOLLOWER REMAINS IN NOTCH OF GEARBOX OUTPUT CAM DURING "SKIP" CYCLE. NOTE: ALSO, SEE SYMPTOM 9.	SKIP DELAY SWITCH (S304) CLOSES TOO SOON.	RETARD ACTUATION POINT OF SKIP DELAY ACTUATING CAM. REFER TO "SKIP DELAY SWITCH ADJUSTMENT" PROCEDURE UNDER SERVICE ADJUSTMENTS.
(9) CAM FOLLOWER FALLS BACK INTO NOTCH OF GEARBOX OUTPUT CAM ON THE "SKIP" CYCLE, THUS ALLOWING THE UNTIMELY OCCURRENCE OF CONTACT BEING MADE BETWEEN THE ROTATING PRINT WHEEL AND THE CHART.	SAME CAUSE AS GIVEN FOR SYMPTOM 8.	SAME REMEDY AS GIVEN FOR SYMPTOM 8.
(10) GEARBOX OUTPUT CAM COASTS TOO FAR BEFORE THE BEGINNING OF THE "SKIP" CYCLE, THE RESULT OF WHICH ALLOWS TOO SHORT A BALANCE TIME FOR A SUCCEEDING "PRINT" CYCLE.	SKIP DELAY SWITCH (S304) CLOSES TOO LATE.	ADVANCE THE ACTUATION POINT OF SKIP DELAY ACTUATING CAM. REFER TO "SKIP DELAY SWITCH ADJUSTMENT" PROCEDURE UNDER SERVICE ADJUSTMENTS.
(11) PRINT WHEEL FAILS TO ADVANCE ON A POINT WHICH IS SKIPPED DURING A "SKIP" CYCLE; AND THEREAFTER, PRINT WHEEL REMAINS UNSYNCHRONIZED WITH THE POINT SELECTION OF THE SELECTOR SWITCH.	ROTOR OF PROGRAM SWITCH DECK LEAVES THE CONTACT OF THE SKIPPED POINT TOO SOON.	REFER TO "ROTOR ADJUSTMENT OF PROGRAM SWITCH DECK" UNDER SERVICE ADJUSTMENTS IN THIS SUPPLEMENT. AFTER MAKING ADJUSTMENT OF PROGRAM SWITCH ROTOR, RE-SYNCHRONIZE PRINT WHEEL, POINT INDICATOR WHEEL, AND MULTICOLOR INK WHEEL (IF USED) WITH POINT SELECTION OF SELECTOR SWITCH ASSEMBLY. REFER TO SUBJECT ITEMS D AND E UNDER TOPIC HEADING "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM" IN PART 3, SECTION III (MAINTENANCE) OF THIS MANUAL.

TABLE 4. TROUBLESHOOTING GUIDE (CONT'D.)

SYMPTOM	POSSIBLE CAUSE	REMEDY
(12) PRINT MOTOR REVERSES ITS DIRECTION OF ROTATION ON "SKIP" CYCLE BUT SELECTOR SWITCH DOES NOT ADVANCE TO NEXT POINT, THUS CAUSING THE RECORDER TO REMAIN IN THE "SKIP" CYCLE.	CLUTCH B (FIGURE 4) SLIPS.	TEST OPERATION OF CLUTCH AS OUTLINED UNDER TESTING PROCEDURES. REPLACE CLUTCH IF DEFECTIVE. REFER TO "CLUTCH REPLACEMENT" PROCEDURE AS OUTLINED UNDER COMPONENTS REPLACEMENT.
	LOOSE COUPLING LINKAGE BETWEEN SELECTOR SWITCH SHAFT AND GEARBOX SHAFT.	SECURE COUPLING COMPONENTS ON THEIR RESPECTIVE SHAFTS.
(13) SOME POINTS ARE PROGRAMMED TO "SKIP," BUT RECORDER CONTINUES TO "PRINT" ON ALL POINTS.	SKIP DELAY ACTUATING CAM (FIGURE 4) LOOSE ON ITS SHAFT.	ADJUST AND TIGHTEN SKIP DELAY ACTUATING CAM TO PROPER POSITION. REFER TO "SKIP DELAY SWITCH ADJUSTMENT" PROCEDURE UNDER SERVICE ADJUSTMENTS.
	DEFECTIVE RELAY (K301).	REPLACE RELAY.
	DEFECTIVE COMPONENTS IN CIRCUITRY TO MOTOR-REVERSING RELAY (K301).	REFER TO FIGURE 13 AND CHECK COMPONENTS S304, CR301, CR302, AND R302. REPLACE DEFECTIVE COMPONENTS.
(14) A PARTICULAR POINT (OR POINTS) PROGRAMMED TO "SKIP" IS INSTEAD PRINTED. OTHER POINTS PROGRAMMED TO "SKIP" ARE SKIPPED IN THE NORMAL MANNER.	DEFECTIVE PROGRAM SWITCH(ES).	REPLACE PROGRAM SWITCH(ES).

SERVICE ADJUSTMENTS

THE SERVICE ADJUSTMENTS WHICH FOLLOW ARE SPECIFIC TO A MULTIPOINT RECORDER EQUIPPED WITH THE PROGRAMMED PRINTING OPTION. REFER TO PART 3, SECTION III (MECHANICAL MAINTENANCE SECTION) IN THIS MANUAL FOR ALL OTHER MECHANICAL ADJUSTMENT PROCEDURES PERTINENT TO THE STANDARD MULTIPOINT (NO OPTIONS EMPLOYED) RECORDER.

ROTOR ADJUSTMENT OF PROGRAM SWITCH DECK

IN THE NORMAL "PRINT" CYCLE, THE PRINT WHEEL IS ADVANCED BY THE ROTATION OF THE POINT (STATION) ADVANCE PINION, THE RISING MOTION OF THE PRINTHEAD, AND THE WEDGING ACTION OF THE DETENT SPRING IN THE PRINTHEAD. REFER TO SUBJECT HEADING ENTITLED "MECHANICAL ANALYSIS OF PRINT CYCLE" IN PART 3, SECTION I OF THIS MANUAL.

WHEN THE PRINT WHEEL IS ADVANCED DURING A "SKIP" CYCLE, THE PRINTHEAD STANDS STILL AND DOES NOT AID THE ADVANCEMENT OF THE PRINT WHEEL. THIS SITUATION MAY CAUSE A MALFUNCTION WHEN A SINGLE POINT (STATION) IS TO BE SKIPPED OR WHEN THE LAST POINT IN A SERIES OF POINTS IS TO BE SKIPPED. THE RESULT OF THIS MALFUNCTION IS THAT THE PRINT WHEEL FAILS TO ADVANCE TO THE NEXT POINT (STATION) FROM THE PREVIOUS POINT THAT WAS PROGRAMMED TO BE SKIPPED.

THE CAUSE OF THIS MALFUNCTION IS DUE TO THE FACT THAT THE ROTOR OF THE PROGRAM SWITCH DECK IS TOO SOON ADVANCED TO THE NEXT POINT WHICH HAS BEEN PROGRAMMED TO

BE PRINTED. THE CONCLUDING RESULT IS THAT THE INTERACTION BETWEEN THE DETENT WHEEL AND THE DETENT SPRING IN THE PRINTHEAD FAILS TO ADVANCE THE PRINT WHEEL TO THE NEXT POINT.

THIS MALFUNCTION IS CORRECTED BY ADJUSTING THE ROTOR OF THE PROGRAM SWITCH TO LAG SLIGHTLY BEHIND THE ROTOR OF THE SIGNAL SWITCH DECK. THIS ADJUSTMENT CAUSES A DELAY IN THE REVERSAL OF THE PRINT MOTOR TO THE "PRINT DIRECTION," THUS ALLOWING THE PRINT WHEEL TO MAKE ITS PROPER ADVANCE TO THE NEXT POINT.

THIS ROTOR ADJUSTMENT HAS BEEN CAREFULLY MADE AT THE FACTORY AND SHOULD NOT REQUIRE FURTHER ATTENTION IN THE FIELD. HOWEVER, IF CORRECTIVE MAINTENANCE HAS BEEN PERFORMED, THE ORIGINAL FACTORY ADJUSTMENT MAY HAVE BEEN DESTROYED, THUS NECESSITATING A RE-ADJUSTMENT.

IMPORTANT: BEFORE PROCEEDING WITH THE ROTOR ADJUSTMENT, CHECK FOR PROPER ADJUSTMENT OF THE SELECTOR SWITCH OUTPUT PINION DESCRIBED IN STEP 17 UNDER TOPIC HEADING "ADJUSTMENTS OF THE PRINTING AND INPUT SELECTION MECHANISM" FOUND IN PART 3, SECTION III (MAINTENANCE) OF THIS MANUAL.

ADJUST ROTOR OF PROGRAM SWITCH DECK AS FOLLOWS (REFER TO FIGURE 2):

(1) REMOVE POWER FROM INSTRUMENT AND REMOVE COVER FROM TOP OF SELECTOR SWITCH ASSEMBLY.

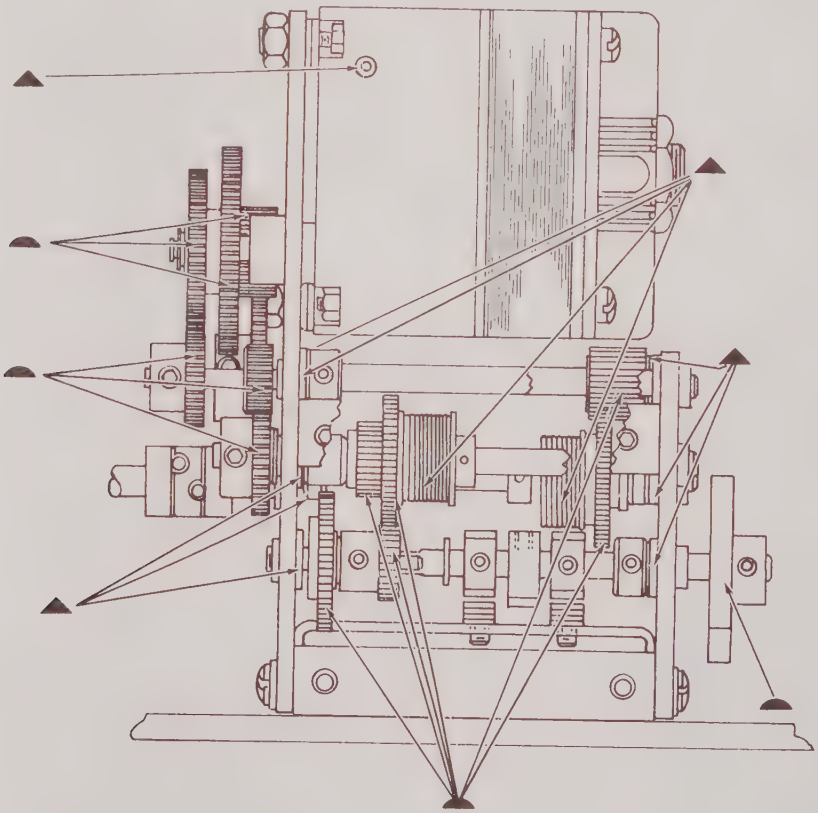


FIGURE 7. GEARBOX LUBRICATION POINTS.

(2) Loosen screw in rotor hub and rotate rotor about 1/16" in the counterclockwise direction. Retighten screw.

(3) Position the program switches as outlined under topic heading "Set-Up of Program Switches" in this supplement.

(4) Apply power to recorder. Check to see that print wheel advances after each point that is skipped. Re-adjust rotor, if necessary, until proper results are obtained. After final adjustment is made, seal screw with "Glyptal" or an equivalent cement.

NOTE: The rotor(s) associated with other switch decks in a multi-deck switch assembly may now advance past the centers of the next contact pair after the "skip" cycle. This condition, however, presents no malfunction as long as the rotor associated with a make-before-break type signal switch deck does not bridge to the next contact pair.

(5) Replace cover on selector switch assembly.

Skip Delay Switch Adjustment (Refer to Figure 2)

Adjust timing of skip delay switch (S304) as follows:

(1) Remove power from instrument and remove cover from top of gearbox.

(2) Unplug motor reversing relay (Figure 1).

(3) Connect an ohmmeter across pins 1 and 3 of the relay socket (see Figure 8B).

(4) Manually rotate the gearbox output cam in a counterclockwise direction until cam follower drops into the cam notch. Slowly continue to rotate output cam so that cam follower is driven out of the notch and about 1/4" past the highest rise of the cam as shown in Figure 8A. At this point, the skip delay actuating cam should close the skip delay switch as indicated by a zero-ohm reading on the ohmmeter.

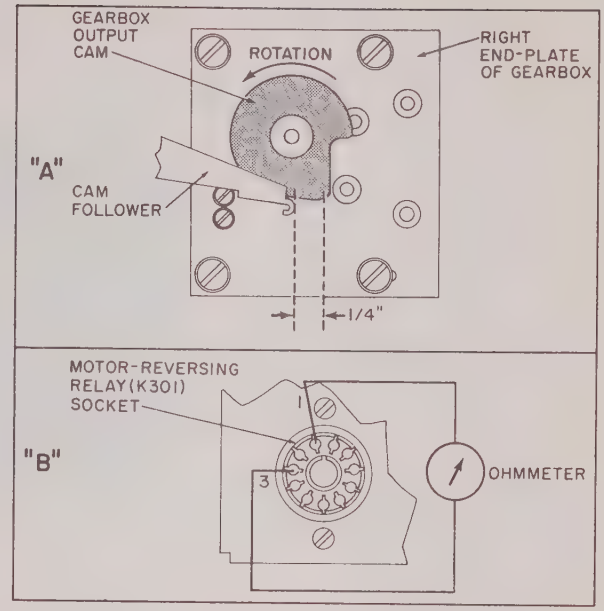


FIGURE 8. CHECKING SKIP DELAY SWITCH ADJUSTMENT.

(5) If the skip delay switch closes too soon or too late, loosen setscrew in skip delay cam and position cam to obtain the correct timing. Retighten setscrew and seal with "Glyptal" or an equivalent cement.

(6) Remove ohmmeter connections from relay socket and plug in relay. Replace cover on gearbox.

(7) Position the program switches as outlined under topic heading "Set-Up of Program Switches" in this supplement.

(8) Apply power to recorder and observe the relationship between the output cam and the cam follower on a "skip" cycle. When a point is being skipped, output cam should stop turning when cam follower is at approximate position shown in Figure 8A.

(9) If proper results are not obtained, carefully repeat Steps 1 through 8 above.

TESTING PROCEDURES

Resistance Check of Print Motor (B302) Windings

(1) Remove power from instrument.

(2) Place print motor switch in OFF position and remove cover from terminal block TB303.

(3) Check for following resistance readings:

Connect Ohmmeter Across Terminals:	Resistance Reading:
1 and 2 of TB303	44Ω, ±10%
1 and 3 of TB303	44Ω, ±10%
2 and 3 of TB303	88Ω, ±10%

(4) Replace motor if defective. See "Components Replacement" in this supplement. If motor checks okay, replace cover on terminal block TB303.

Checking for Defective Clutch Operation in Gearbox (Refer to Figure 4)

(1) Remove power from instrument and remove cover from top of gearbox.

(2) Unlatch and swing out chart frame mechanism so that cam follower is allowed to fall to its lowest extremity.

(3) Manually turn gearbox output cam in a clockwise direction (as viewed from output side of gearbox). The selector switch drive shaft should also rotate in a clockwise direction. This response indicates that both clutches A and B are properly engaging.

(4) Now manually turn the output cam in a counterclockwise direction. The selector switch drive shaft should remain motionless. This response indicates that clutch A is properly disengaging.

(5) Now rotate gear cluster L in a counterclockwise direction (as viewed from input side of gearbox) so that gear P is also driven counterclockwise. The selector switch drive shaft should again remain motionless. This response indicates that clutch B is properly disengaging.

(6) Swing chart frame mechanism back into place.

If any of the above checks indicate that either one of the clutches is not properly engaging or disengaging when it should, first inspect for a broken spring. If the spring is intact, clean and lubricate the clutch. Refer to Figure 7 for lubrication points.

If either clutch proves to be defective, replace the defective clutch. See "Components Replacement" in this supplement. If clutches check okay, replace gearbox cover.

COMPONENTS REPLACEMENT

To Replace Print Motor (B302)

(1) Remove power from instrument and swing out frame assemblies from case.

(2) Disconnect white, red, black (and blue) motor leads from terminals 3, 2, and 1 respectively on terminal block TB303.

(3) Loosen setscrew in motor pinion and remove from motor shaft.

(4) Remove two motor mounting nuts. Remove motor and four spacer washers.

(5) Mount new motor with two mounting nuts and the four spacer washers. Replace motor pinion on motor shaft so that gear mesh between motor pinion and the other driven gears is properly centered. Tighten setscrew in motor pinion against the flat on the motor shaft. Seal setscrew with "Glyptal" or an equivalent cement.

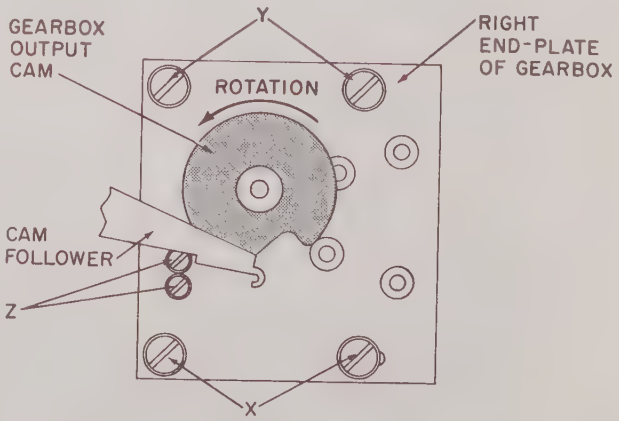


FIGURE 9. GEARBOX DISASSEMBLY.

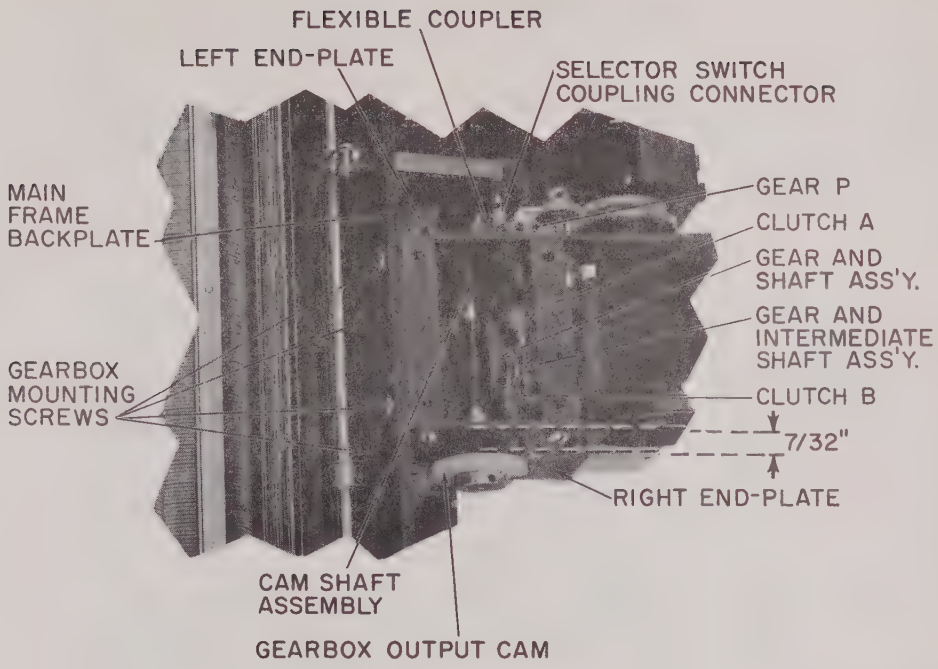


FIGURE 10. GEARBOX REMOVAL AND SERVICING.

(6) Connect white, red, black (and blue) motor leads to terminals 3, 2, and 1 respectively on terminal block TB303. Turn on instrument and check operation.

To Replace Gearbox Clutches

Refer to Figure 10 and proceed as follows:

(1) Remove power from instrument and swing out frame assemblies from case. Unlatch chart drive frame and swing it out from main mechanism frame. Remove four screws and remove cover from top of gearbox.

(2) Remove four gearbox mounting screws and remove gearbox assembly from main frame backplate. Handle gearbox so that wire cabling between gearbox and terminal block TB401 is not overstrained.

NOTE: When removing the gearbox, the flexible (plastic) coupler may remain intact with the selector switch coupling connector or it may come off with the gearbox coupling connector.

(3) Refer to Figure 9 and proceed as follows:

a. Remove two screws (X) and two screws (Y). Remove two screws (Z) which secure one end of the switch bracket to the right end-plate.

b. Loosen two setscrews in hub of gearbox output cam and remove output cam.

(4) Remove right end-plate from gearbox assembly.

(5) To replace clutch A, proceed as follows:

a. Pull and remove cam shaft assembly from left end-plate.

CAUTION: When removing cam shaft assembly, be careful not to damage leaf switches. Also, do not inadvertently loosen and change angular position of the switch actuating cams. These cams are precisely adjusted for the correct timing actuation of their respective switch.

b. Loosen two setscrews in external gear P. Pull and remove gear and intermediate

SHAFT ASSEMBLY FROM LEFT END-PLATE.

C. LIFT END OF OLD CLUTCH SPRING OVER LIP OF DRIVING MEMBER AND THREAD SPRING OVER AND OFF DRIVING MEMBER. REMOVE OLD CLUTCH SPRING FROM ASSEMBLY.

D. THREAD NEW CLUTCH SPRING IN PLACE.

E. PLACE EXTERNAL GEAR P (HUB OUT) IN MOUNTING POSITION. INSERT GEAR AND INTERMEDIATE SHAFT ASSEMBLY INTO ITS PROPER BEARING ON THE LEFT END-PLATE. TIGHTEN TWO SETSCREWS IN GEAR P AGAINST THE FLATS ON THE SHAFT. SEAL SETSCREWS WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

F. CAREFULLY INSERT CAM SHAFT ASSEMBLY INTO ITS BEARING ON THE LEFT END-PLATE.

(5) TO REPLACE CLUTCH B, PROCEED AS FOLLOWS:

A. REMOVE EXTERNAL COUPLING CONNECTOR FROM END OF GEAR AND SHAFT ASSEMBLY.

B. PULL AND REMOVE GEAR AND SHAFT ASSEMBLY FROM LEFT END-PLATE.

C. LIFT END OF OLD CLUTCH SPRING OVER LIP OF DRIVEN MEMBER AND THREAD SPRING OVER AND OFF DRIVEN MEMBER. REMOVE OLD CLUTCH SPRING FROM GEAR AND SHAFT ASSEMBLY.

D. THREAD NEW CLUTCH SPRING IN PLACE.

E. INSERT GEAR AND SHAFT ASSEMBLY INTO ITS BEARING ON THE LEFT END-PLATE. INSTALL EXTERNAL COUPLING CONNECTOR ON END OF SHAFT. TIGHTEN TWO SETSCREWS IN CONNECTOR AGAINST THE FLATS ON THE SHAFT. SEAL SETSCREWS WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

(6) MAKE SURE THAT GEARS IN GEARBOX ARE ENGAGING PROPERLY. ALIGN SHAFTS OF GEARBOX WITH BEARING OPENINGS IN RIGHT END-PLATE, AND INSTALL RIGHT END-PLATE ON GEARBOX.

(7) INSTALL TWO SCREWS (Y), TWO SCREWS (X), AND TWO SCREWS (Z). INSTALL GEARBOX OUTPUT CAM ON CAM SHAFT. POSITION OUTPUT CAM ON SHAFT TO OBTAIN 7/32" DIMENSION BETWEEN RIGHT END-PLATE AND INNER SURFACE OF OUTPUT CAM (SEE FIGURE 10). TIGHTEN TWO SETSCREWS IN OUTPUT CAM AGAINST THE FLATS ON THE SHAFT. SEAL SETSCREWS WITH "GLYPTAL" OR AN EQUIVALENT CEMENT.

(8) LUBRICATE GEARBOX AT POINTS SHOWN IN FIGURE 7.

(9) PLACE GEARBOX ASSEMBLY IN MOUNTING POSITION AND SECURE TO MAIN FRAME BACKPLATE WITH FOUR MOUNTING SCREWS.

(10) ENGAGE COUPLING LINKAGE BETWEEN GEARBOX AND SELECTOR SWITCH.

(11) CHECK FOR PROPER OPERATION OF CLUTCHES AS OUTLINED UNDER "TESTING PROCEDURES." REPLACE GEARBOX COVER.

(12) SWING CHART DRIVE FRAME BACK INTO PLACE.

(13) TURN ON INSTRUMENT AND CHECK FOR PROPER OPERATION OF THE "PRINT" AND "SKIP" MODES.

ILLUSTRATED PARTS BREAKDOWN

THE PARTS LISTING FOR A MULTIPOINT RECORDER EQUIPPED WITH THE PROGRAMMED PRINTING OPTION REMAINS THE SAME AS THE BREAKDOWN OF PARTS LISTED IN PART 4, SECTION II (MEASURING SYSTEM ASSEMBLY) OF THIS MANUAL--EXCEPT FOR THE PARTS PERTAINING TO THE SELECTOR SWITCH ASSEMBLY AND THE GEARBOX ASSEMBLY. REFER TO THE FOLLOWING PARTS LIST FOR PARTS BREAKDOWN OF THESE ASSEMBLIES.

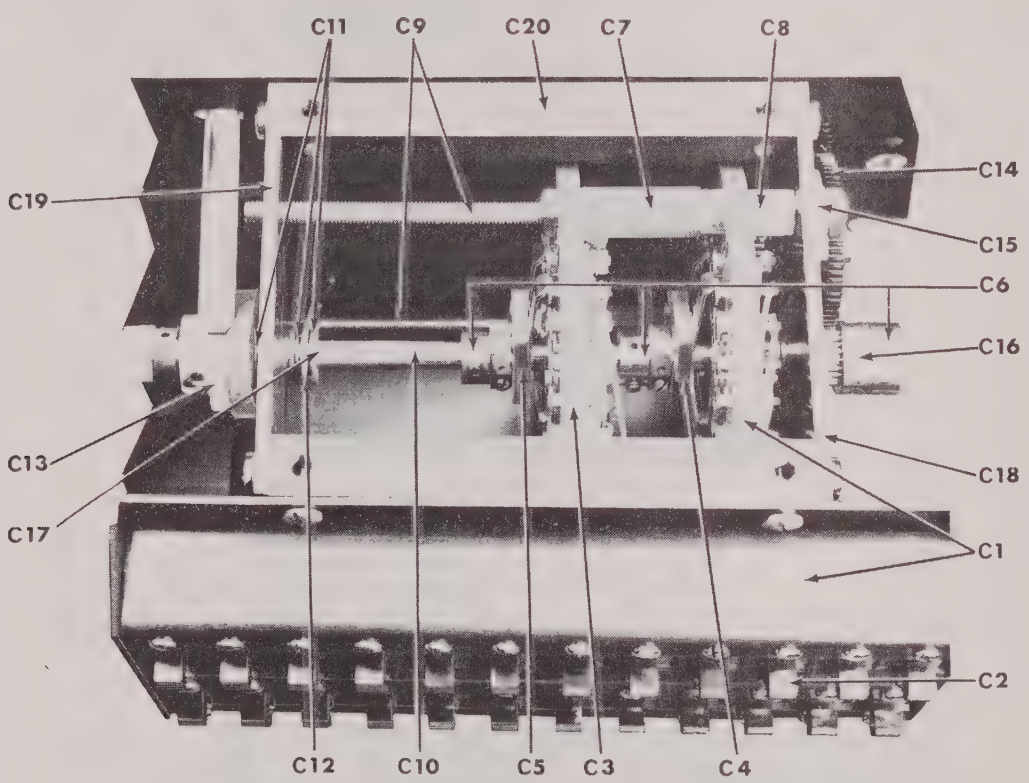


FIGURE 11. SELECTOR SWITCH ASSEMBLY (PROGRAMMED PRINTING).

SELECTOR SWITCH ASSEMBLY REPLACEMENT PARTS LIST

FIG. 11 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	50908†	SELECTOR SWITCH ASS'Y; INCLUDES SHORTING TYPE (MBB*) SIGNAL SWITCH DECK	1
	50910†	SELECTOR SWITCH ASS'Y; INCLUDES NON-SHORTING TYPE (BBM**) SIGNAL SWITCH DECK	1
C1	50947	PROGRAM SWITCH DECK ASS'Y. (MBB*); INCLUDES PROGRAM SWITCH PANEL AND CABLE	1
C2	51166	SWITCH, PROGRAM	24
C3†	50906	SIGNAL SWITCH DECK (MBB*) AND CABLE ASSEMBLY	1
	50907	SIGNAL SWITCH DECK (BBM**) AND CABLE ASSEMBLY	1
C4†	63207-2	ROTOR, PROGRAM SWITCH DECK (MBB*)	1
C5	63207-2	ROTOR, SIGNAL SWITCH DECK (MBB*)	1
	51126-2	ROTOR, SIGNAL SWITCH DECK (BBM**)	1
C6	51362	COLLAR	3
C7	50932-1	SPACER	3
C8	51469	NUT, SWITCH	3

* MAKE-BEFORE-BREAK
** BREAK-BEFORE-MAKE
† SEE DATA SHEET FOR SELECTOR SWITCH ASSEMBLY PART NUMBER AND THE TYPE OF SIGNAL SWITCH DECK (MBB OR BBM) AND CORRESPONDING ROTOR (MBB OR BBM) SUPPLIED.

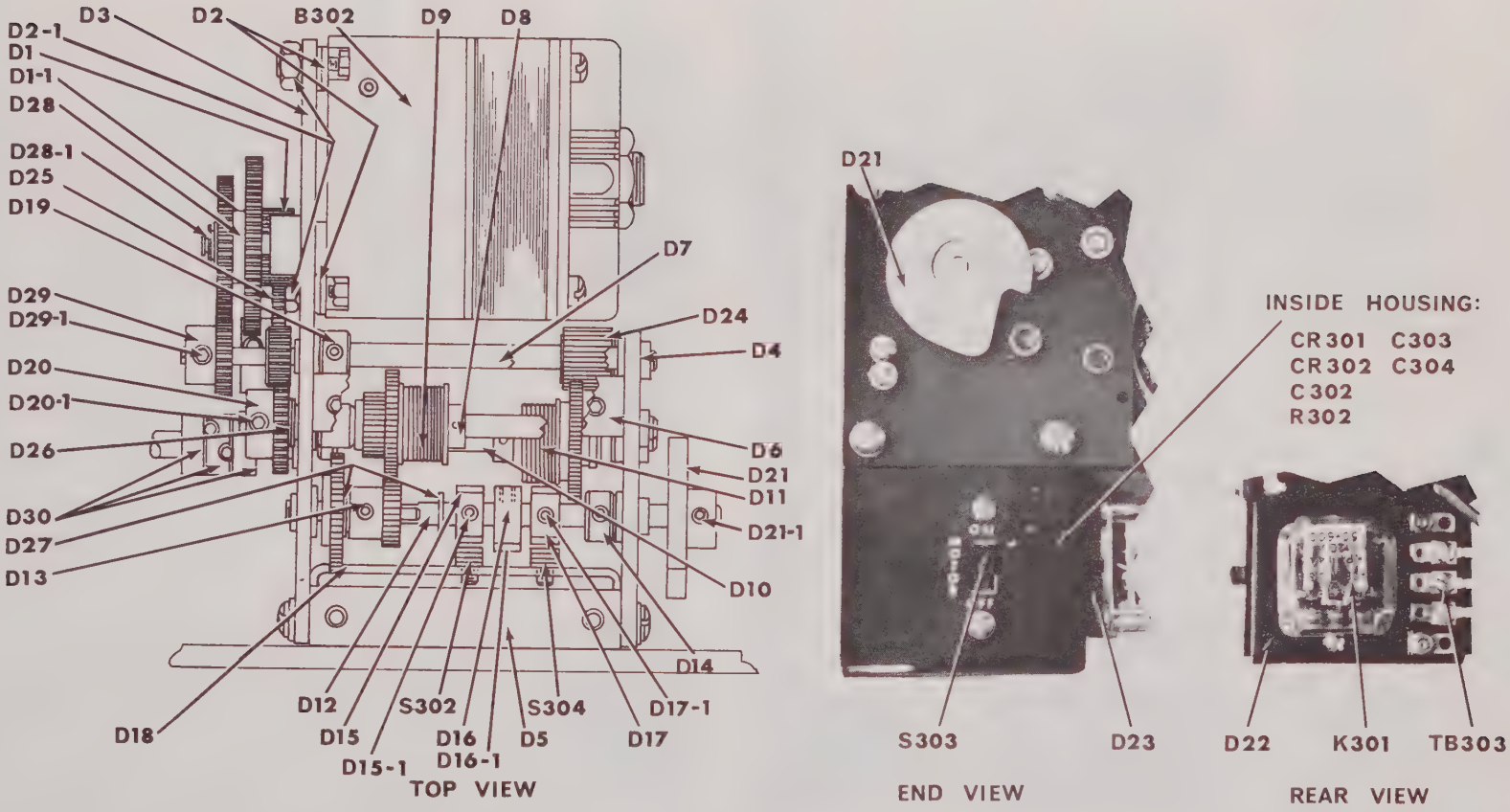


FIGURE 12. GEARBOX ASSEMBLY (PROGRAMMED PRINTING).

SELECTOR SWITCH ASSEMBLY REPLACEMENT PARTS LIST (Cont'd.)

FIG. 11 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
C9	51201	Stud	3
C10	51251	Shaft	1
C11	243144-1	Washer, Thrust	4
C12	ND40178-2	Bearing, Thrust	1
C13	51422	Ratchet Assembly	1
C14	51421	Gear Assembly	1
C15	51361	Mounting Plate Assembly	1
C16	51143	Pinion Assembly	1
C17	ND40140-8	"E" Ring	1
C18	50959	Plate Assembly	1
C19	50959	Plate Assembly	1
C20	50935	Post Spacer	4
	50939	Cover, Switch	1

GEARBOX ASSEMBLY REPLACEMENT PARTS LIST

FIG. 12 INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
	50865†	Gearbox Ass'y. (60Hz Operation); Includes Index No's. B302, D1, D1-1, D2, and D2-1	1
	50865-1θ	Gearbox Ass'y. (60Hz Operation); Less Index No's. B302 D1, D1-1, D2, and D2-1.	1
B302	50858	Print Motor	1
D1	50854	Pinion, Motor	1
D1-1	SS083203	Setscrew, Motor Pinion	1
D2	NX-1008	Washers, Spacer	4
D2-1	NX-2008	Mounting Nuts, Motor	2
D3	50866	Left-Hand Plate Assembly	1
D4	50868	Right-Hand Plate Assembly	1
D5	51287	Post, Spacer	1
D6	51325	Post, Spacer	3
D7	51467	Pinion and Shaft Assembly	1
D8	50852	Gear and Intermediate Shaft Assembly	1
D9	40314	Spring, Clutch	1
D10	51367	Gear and Shaft Assembly	1
D11	40314	Spring, Clutch	1
D12	51443	Shaft, Cam	1
D13	51442	Gear, Pinion, and Hub Assembly	1
D14	51451	Hub	1
D15	51239	Cam, Signal Cutoff Switch Actuating	1
D15-1	SS063203	Setscrew, Signal Cutoff Cam	1
D16	51382	Cam, Selective Alarm Switch Actuating (Selective Alarm Option)	1
D16-1	SS063202	Setscrew, Selective Alarm Cam	1
D17	51239	Cam, Skip Delay Switch Actuating	1
D17-1	SS063203	Setscrew, Skip Delay Cam	1
S302		Signal Cutoff Switch Assembly:	1
	243211	Actuator, Switch	1
	243212	Contact, Actuated (Silver)	1
	243213	Contact, Fixed (Palladium)	1
S304		Skip Delay Switch Assembly:	1
	243211	Actuator, Switch	1
	243212	Contact, Actuated (Silver)	1
	243213	Contact, Fixed (Palladium)	1

† For 50Hz Operation, Part No. Becomes 50865-2.
θ For 50Hz Operation, Part No. Becomes 50865-3.

GEARBOX ASSEMBLY REPLACEMENT PARTS LIST (Cont'd.)

FIG. 12 INDEX NO.	PART NUMBER		QTY.
D18	51306	Bracket, Switch Mounting	1
D19	51451	Hub	1
D20	51378	Gear	1
D20-1	SS063203	Setscrew, Gear	2
D21	51162	Output Cam Assembly	1
D21-1	SS063202	Setscrew, Output Cam	2
D22	51257	Housing, Motor Control	1
CR301	43421	Diode, Arc Suppression (IN4004)	1
CR302	43421	Diode, Rectifier (IN4004)	1
C302		Capacitor:	1
	13429	1.2mfd @ 220V AC, 60Hz Applications	
	10534	1.5mfd @ 220V AC, 50Hz Applications	
C303	1CC11-20	Capacitor, .02mfd @ 600V	1
C304	1CC11-20	Capacitor, .02mfd @ 600V	1
R302	1RR289-1K	Resistor, 1000Ω, 3W, 5%	1
S303	51166	Switch, Print Motor	1
D23	1CP4-11	Socket, Relay	1
TB303	52578-3	Terminal Block	1
K301	51486	Relay, Motor-Reversing	1
D24	50853	Pinion Shaft and Collar Assembly	1
D25	51379	Gear and Hub Assembly	1
D26	X-1010	Washer	1
D27	NDL0140-7	"E" Retaining Ring	2
D28	***	Driving Gear Cluster (Optional; See Table 2):	1
	50859	1 and 4 Sec. Print Freq. (Red)	
	51460	1.5 and 6 Sec. Print Freq. (Aluminum)	
	51461	3 and 12 Sec. Print Freq. (Black)	
	51490	6 and 24 Sec. Print Freq. (Aluminum)	
	51462	7.5 and 30 Sec. Print Freq. (Blue)	
	51463	15 and 60 Sec. Print Freq. (Copper)	
D28-1	ND40140-6	"E" Retaining Ring, Driving Gear Cluster	1
D29	***	Driven Gear (Optional; See Table 2):	1
	50855	1 and 4 Sec. Print Freq. (Copper)	
	51456	1.5 and 6 Sec. Print Freq. (Aluminum)	
	51457	3 and 12 Sec. Print Freq. (Black)	
	51379	6 and 24 Sec. Print Freq. (Aluminum)	
	51458	7.5 and 30 Sec. Print Freq. (Blue)	
	51459	15 and 60 Sec. Print Freq. (Copper)	
D29-1	SS063203	Setscrew, Driven Gear	2
D30	51357	Coupling Assembly	1

***Refer to Instrument DATA SHEET for Specified Print Frequency Furnished on Instrument.

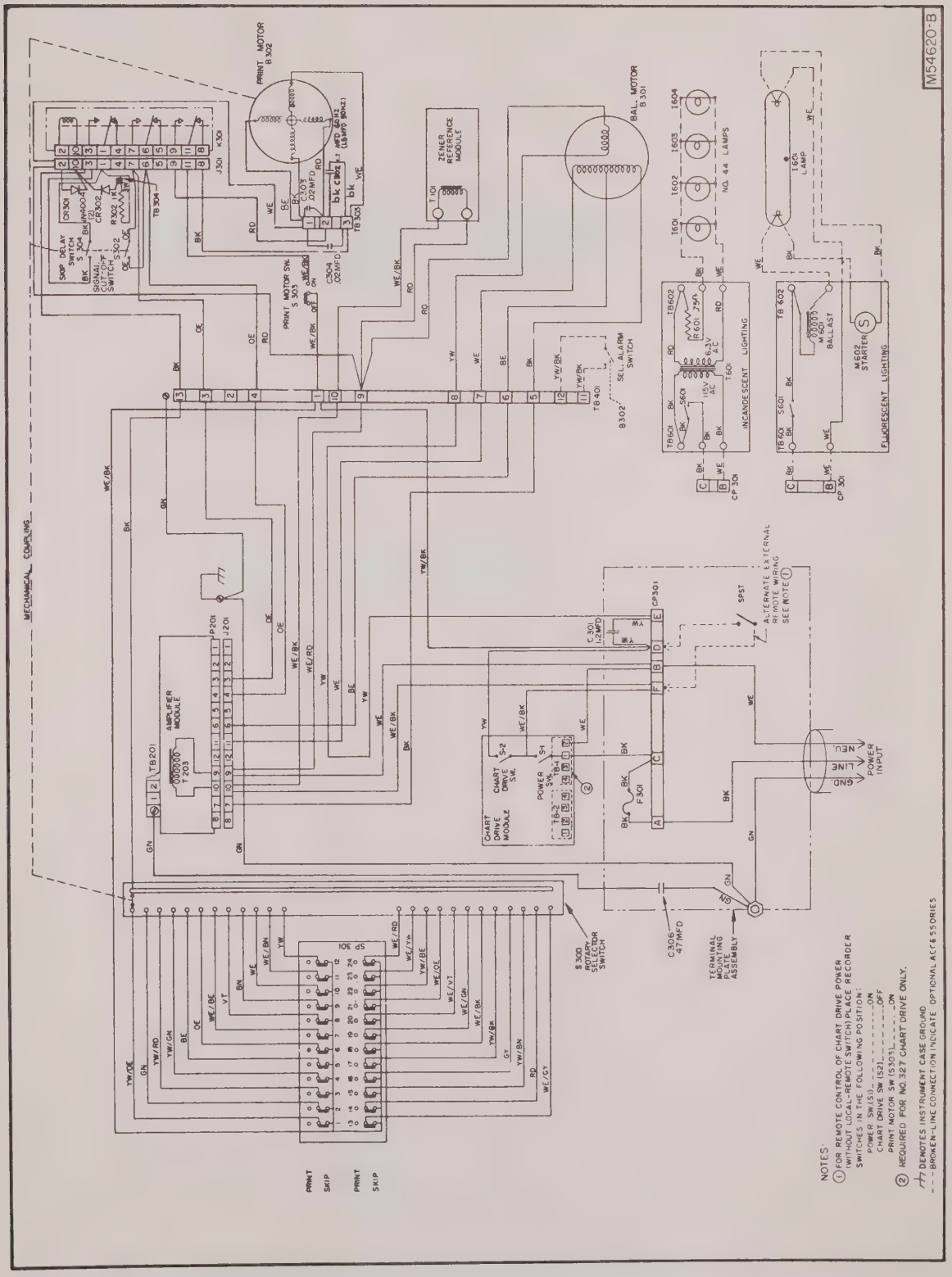


FIGURE 13. POWER WIRING DIAGRAM (PROGRAMMED PRINTING).

IMPORTANT

TECHNICAL DATA

ENCLOSED

Serial Number 943066

Instruments for Data Acquisition • Analysis • Recording • Controlling

- Space Exploration
- Scientific Research
- Production Analysis
- Process Monitoring and Control

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